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CHARLOTTETOWN AIRPORT
REDEVELOPMENT PROJECT
WATER RESOURCES ASSESSMENT

81-WPMB-5

Inland Waters Directorate
Atlantic Region
Dartmouth, Nova Scotia
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PREFACE

The Inland Waters Directorate, Atlantic Region, has published a series of reports focussing on water resource issues associated with the proposed Charlottetown Airport redevelopment project. The initial report entitled "Interim Report, Water Resources Assessment, Phase 1, Proposed Expansion of the Charlottetown Airport", was published in July 1978. Based in part on the interim report, additional hydrologic data collected during the period 1978 to 1980, and further discussions with several federal and provincial agencies, the final report, entitled "Charlottetown Airport Redevelopment Project, Water Resources Assessment", was published in April 1981.

This report is a revision of the final report which has been necessitated by a number of numerical inconsistencies. In addition, several conclusions and recommendations were clarified, and in some instances altered, to reflect more recent information on the project.

ABSTRACT

A number of water resource concerns are associated with the proposed Charlottetown Airport Redevelopment Project. The existing airport, and to a greater extent the redeveloped airport, is situated in the recharge area of aquifers which supply water to the City of Charlottetown and to a number of individual users with private supplies. The potential impairment of groundwater quality resulting from the use of urea, hydrocarbon, glycol and associated contaminants such as phenols could pose a serious economic burden to all concerned.

A hydrological monitoring programme was established in 1976 and continued through 1980. Part of the programme involved the drilling of 16 observation wells on and adjacent to the airport property. The test wells penetrated the water table aquifer and were used in conjunction with several private wells to monitor water table fluctuations. Water samples were obtained from the observation wells, from the three municipal well fields and from various streams which drain the airport property. The extent to which water quality is affected by existing airport operations and the potential for further pertubations resulting from airport redevelopment is evaluated and discussed. Groundwater flow patterns and the potential for earth materials to attenuate subsurface contaminants are also discussed. The study concludes with 24 recommendations directed towards mitigation of undesired water quality impacts.

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1. INTRODUCTION

1.1 General

Following the announcement of the expansion to the existing Charlottetown Airport facilities by the Ministry of Transport (MOT), a number of water resource concerns were expressed by federal and provincial environment departments(1). The proposed Airport redevelopment involves the construction of an air terminal building, a combined services building, aprons, taxiways, a 2134 metre east-west runway and supporting infrastructure (Figure 1).

The Charlottetown Airport facility is located on a topographic high, northeast of the City of Charlottetown, on the headwaters of three watersheds; Wrights Creek to the south, North Creek to the west and Winter River to the north. The groundwater divide approximates the surface water divide, suggesting that the proposed expansion is partially located in the recharge area for the Winter River Basin in which two major well fields (Brackley and Union) are located. The Malpeque well field in the North Creek Watershed could also be influenced by the redevelopment project. These well fields serve as a source of water supply for the city of Charlottetown (Figure 2). Accordingly, The Prince Edward Island Department of Community Affairs/Environment Division identified a number of major concerns associated with the redevelopment scheme and stressed the need for the management and protection of groundwater resources in the vicinity of the Airport since deicing, fueling and firefighting activities could result in the contamination of the City's water supply.

Discussions between federal and provincial agencies revealed a number of additional water resource concerns including erosion/siltation, flooding and surface water quality deteriorations, none of which have been fully addressed in this report. The focus of this report is to specifically address the groundwater resource concerns associated with the project. A more exhaustive discussion of potential water resource conflicts can be found in earlier reports prepared by the Inland Waters Directorate (1).

1.2 Need for the Project

The Charlottetown Airport has experienced a dramatic increase in the volume of air traffic over the past 15 years. To date, Transport Canada has either expanded or upgraded these facilities to provide an acceptable level of service to both the airlines and the travelling public. Due to

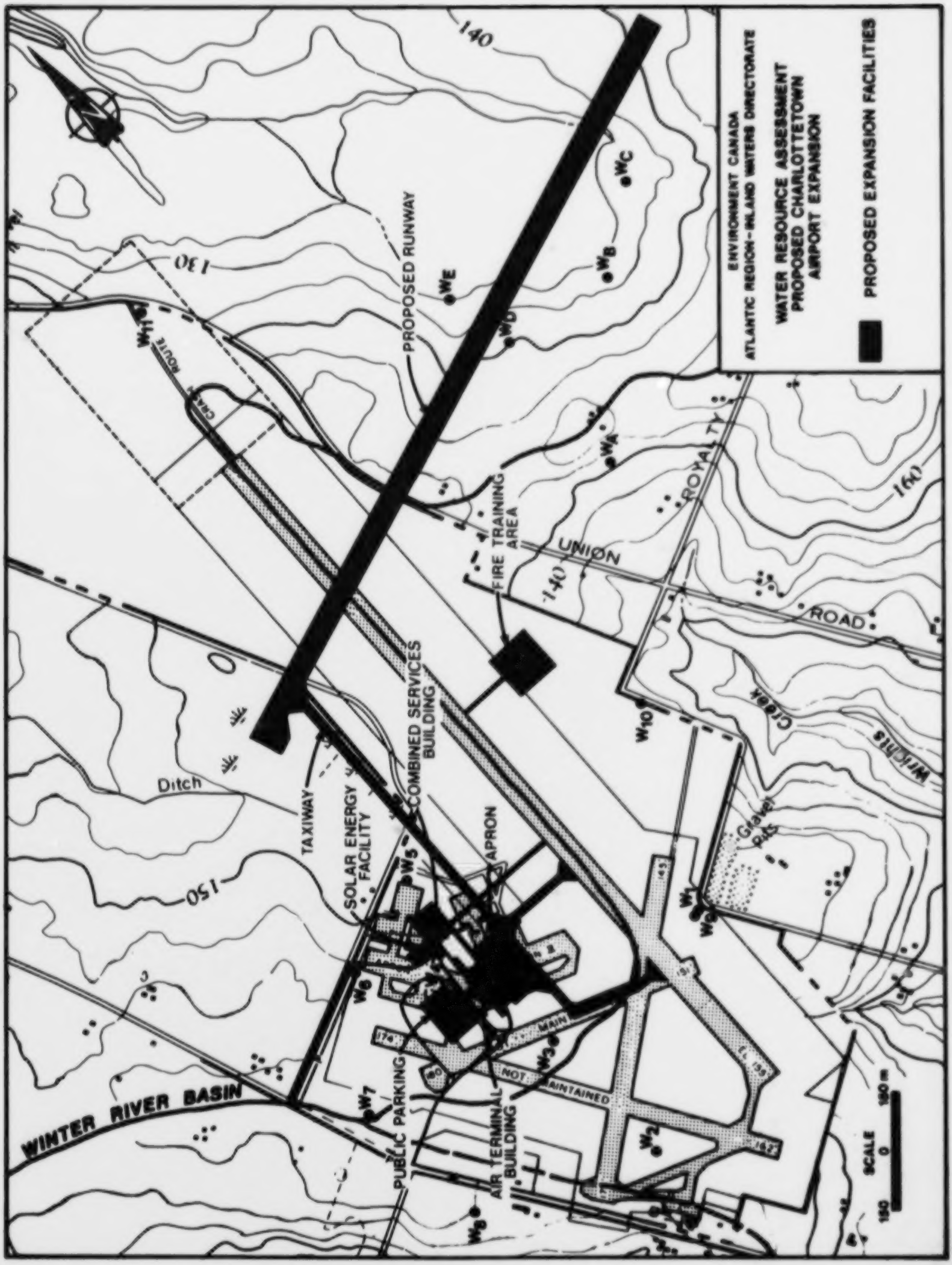

ENVIRONMENT CANADA
ATLANTIC REGION - INLAND WATERS DIRECTORATE
WATER RESOURCE ASSESSMENT
PROPOSED CHARLOTTETOWN
AIRPORT EXPANSION
PROPOSED EXPANSION FACILITIES
PROPOSED RUNWAY
FIRE TRAINING AREA
COMBINED SERVICES BUILDING
TAXIWAY
SOLAR ENERGY FACILITY
APRON
PUBLIC PARKING
AIR TERMINAL BUILDING
WINTER RIVER BASIN
Ditch
UNION
ROAD
ROYALTY
Wrights Creek
Gravel Pits
CRASH ROUTE
MAIN
NOT MAINTAINED
130
140
150
160
WA
WB
WC
WD
WE
W1
W2
W3
W5
W6
W7
W8
W9
W10
W11
SCALE
150
0
150 m

FIGURE 1

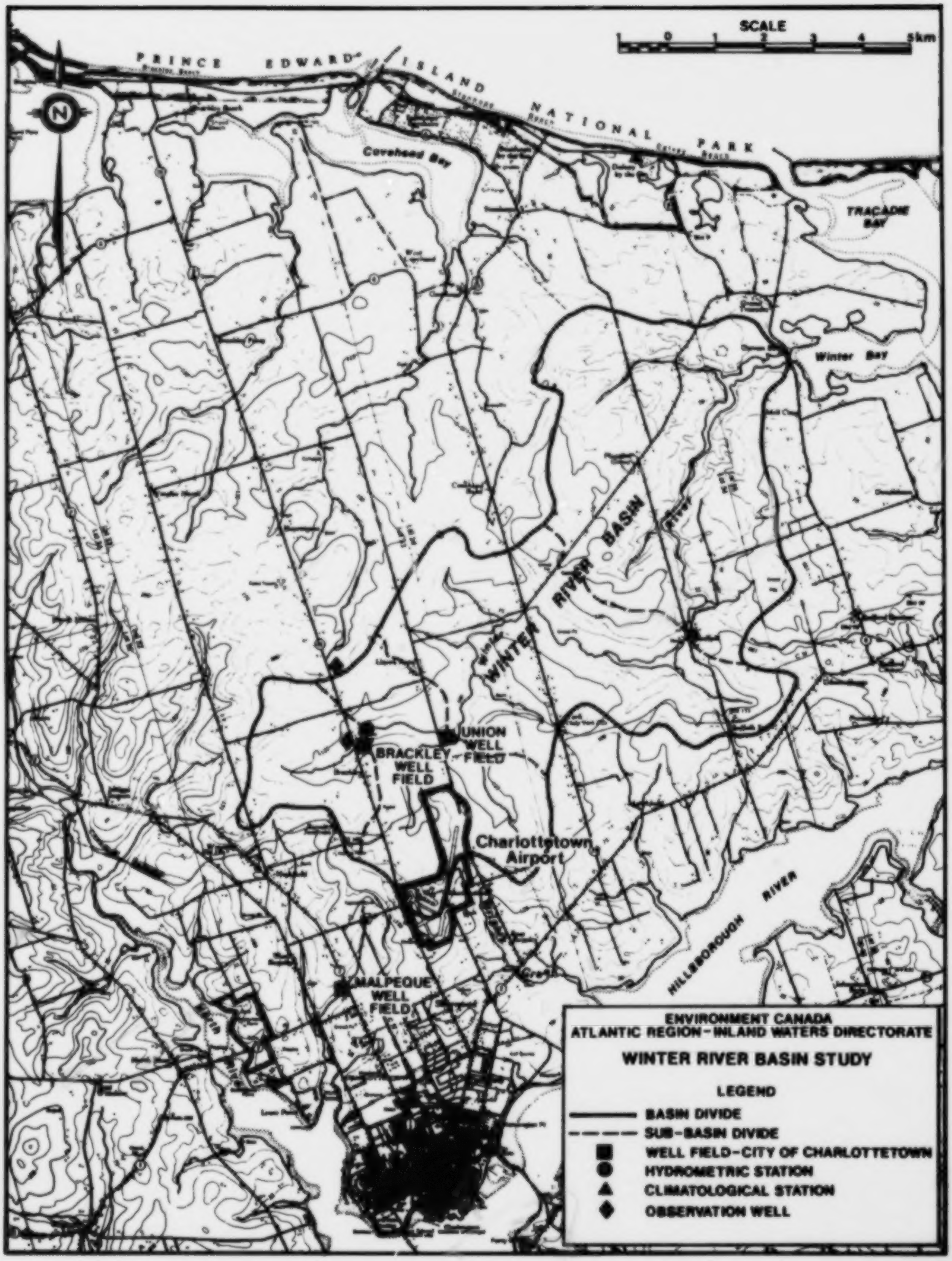

SCALE
0 1 2 3 4 5km
N
PRINCE EDWARD ISLAND NATIONAL PARK
Covehead Bay
TRACADIE BAY
Winter Bay
WINTER RIVER BASIN
BRACKLEY WELL FIELD
UNION WELL FIELD
Charlottetown Airport
HILLSBOROUGH RIVER
MALPEQUE WELL FIELD
ENVIRONMENT CANADA
ATLANTIC REGION - INLAND WATERS DIRECTORATE
WINTER RIVER BASIN STUDY
LEGEND
BASIN DIVIDE
SUB-BASIN DIVIDE
WELL FIELD-CITY OF CHARLOTTETOWN
HYDROMETRIC STATION
CLIMATOLOGICAL STATION
OBSERVATION WELL

FIGURE 2

severe overcrowding, major additions were added to the 1941 terminal building in 1969, 1970, 1973 and 1975 which, although temporarily relieving the problem, did nothing to improve the aesthetics of the building.

However, in recent years, efforts by Transport Canada to upgrade these facilities have been overshadowed by the increasing demand for air transportation, due mainly to the successful promotion of the Prince Edward Island Tourist Program. With three commercial airlines operating out of Charlottetown, the terminal building is often congested, particularly during summer months when the tourist traffic is at its peak. The gravity of the situation is anticipated to become further complicated by the projected increase in air traffic. The Canadian Air Transportation Administration (CATA) predicts that the annual number of passengers will increase from approximately 150,000 in 1974 to 416,000 in 1986 with a corresponding increase in commercial aircraft movements from about 6,000 in 1974 to 9,000 in 1986.

Another problem which has recently surfaced is that of urban encroachment. Residential development has advanced upon the southern boundary of the Airport property to such an extent that some houses are very near the runway approach lights. There is presently no protective zoning regulations around the Airport to restrict any future expansion and, unless plans are soon initiated, development will continue until it could eventually surround the entire Airport. Since there is a growing awareness of noise problems associated with aircraft operations, this residential development, if allowed to continue unchecked, could hamper the future use of the Charlottetown Airport.

In light of these problems, and since Charlottetown is the only commercial Airport serving Prince Edward Island, Regional Ministry of Transport Headquarters in Moncton organized a Master Planning Project Team during February 1974 whose mandate was to propose a development plan in concurrence with the long-term objectives of the Airport. Future requirements were identified and a proposal was developed which included new airside and groundside facilities.

1.3 Brief Description of Project Components

1.3.1 Runway

The future viability of the Airport will be ensured by the proposed airfield system. Analysis identified the requirement for a two-runway system at Charlottetown to meet national policy for wind coverage. It is proposed that a new 1524 metre runway, magnetic bearing 100-280 (east-west), be constructed to replace the existing runways (Figure 1). The runway is anticipated to be constructed and operational by 1984-85. The orientation and location of the runway was established in compliance with accepted standards considering meteorological conditions, noise aggravation, environmental impact and present development.

Noise Exposure Forecasts (NEF's) indicate sensitivity to aircraft noise on the existing main runway (03/21) which could lead to future public complaints. Recognizing this possibility, provisions will be made for the new runway to be expanded to 2134 metres and become the main runway, if and when noise becomes a problem. The Master Plan recommends that the Province, Transport Canada and the affected municipalities work together using the NEF's as a guide to effect land planning in the vicinity of the Airport and to ensure the success of future operations.

1.3.2 Apron/Taxiway

The concrete aircraft parking apron and two connecting taxiways were constructed during the fall of 1978. The new apron is approximately three times larger than the existing apron - 16,723 square metres as opposed to the existing 5184 square metres.

The new taxiway system was developed by Civil Aviation experts with both safety and serviceability in mind. This airfield system is capable of accommodating 14 instrument movements per hour as compared with a forecast maximum demand of 10.5 instrument movements per hour by 1986.

1.3.3 Air Terminal and Operations Buildings

The option to continue modifying and expanding the existing air terminal facilities was rejected. The building is too small, much of it is worn out and land available for expansion of the building is severely restricted. Consideration of future requirements and economic benefits resulted in the decision to construct passenger terminal and operations buildings by 1984. Sizing of the various passenger terminal facilities will be based on national standards, utilizing a forecast peak hourly passenger number of 250 for the design year of 1986. The passenger terminal design will attempt to streamline both enplaning and deplaning processes to minimize delays or confusion to the travelling public while reflecting the needs of Prince Edward Island. The public will have access to a modern bar and a quality restaurant to cater to their needs while at the terminal.

Space will be included in the design for visitor reception facilities, as requested by the Provincial Government. These facilities would be designed primarily for welcoming tourists or tourist groups and providing them with information to make their stay more pleasant. Also included in this area is a VIP lounge for welcoming visiting dignitaries.

A new air traffic control tower will be constructed as part of the operations complex. The tower will permit unobstructed viewing of all runways and their approach paths as dictated by national standards. The new aeradio operations to be incorporated in the complex will provide ground to air communication during hours when the control tower is not in operation.

The Airport administration areas will be located in the operations complex and separated from the main passenger processing area.

1.3.4 Ground Transportation and Parking

Public parking at the passenger terminal area will consist of two lots for long and short term parking. These lots will comprise parking spaces for a total of 349 public vehicles. About 91 linear metres of curbside parking will enable taxis, tour buses and limousines to have direct access to the enplaning and deplaning curbs for drop-offs or pick-ups. Employee and rent-a-car parking will be in separate lots and space will be provided for approximately 100 vehicles.

A well designed roadway system will provide an efficient and unhindered traffic flow.

1.3.5 Maintenance and Emergency Services Facilities

Airport maintenance and emergency service facilities will be housed in a combined services building which was completed in 1979. This building is located to the north of the new passenger terminal complex. The new maintenance garage provides bays for the efficient servicing of Airport equipment. An area for sand and urea storage is also included in the building.

The proposed location will allow emergency service vehicles to have direct access to both the ramp and the airfield in the event of emergencies. Access to the new combined services building will be via a branch road from the main access road which will reduce confusion and congestion on the main road.

1.3.6 Utilities

Heat and air conditioning will be supplied to the new complex from a central plant located in the combined services building.

The power supply for the various Airport facilities will be distributed through a centralized field electrical system also located in the combined services building. The new system will reduce maintenance costs, improve reliability and provide a more flexible system which can be easily expanded. The visual environment of the area will be protected by combining as many services into as few buildings as possible.

The majority of the powerlines to the Airport will be underground cable from the Brackley Point Road.

The sanitary sewage system for the Airport which has recently been installed feeds into the local municipal line. This line will eventually feed into the new pollution control system of the City of Charlottetown.

The Airport's water requirements will be supplied by the City watermain which runs along the Brackley Point Road. Negotiations are continuing regarding power, water and sewer services and some changes could result.

1.4 Purpose and Scope of the Report

1.4.1 Purpose

In response to the concerns expressed by the Prince Edward Island Department of Community Affairs/Environment Division, the Inland Waters Directorate of Environment Canada implemented a water resource investigation of the Airport redevelopment project. The study was coordinated through the Environmental Protection Service (EPS) of Environment Canada the agency responsible for ensuring that environmental protection on federal facilities and lands is adopted by the initiating agency. Terms of reference, which were developed by representatives of Environment Canada, Transport Canada and the Prince Edward Island Department of Community Affairs/Environment Division, were presented in the interim report(1).

The basic objectives of this study were to: (1) characterize the general groundwater flow patterns in the upper aquifers within and adjacent to the proposed Airport complex including consideration of seasonal variability; (2) evaluate the potential ability of in situ surficial and soil materials to attenuate and thus afford natural protection to groundwater resources against contaminants introduced into local aquifer systems by on-going Airport activities; (3) characterize the hydrologic regime for Wrights Creek by defining a flood hydrograph to enable determination of the potential impacts of the redevelopment on the box culvert under the St. Peters Road Highway and the Andrews Pond dam; and, (4) provide a series of recommendations to various federal and provincial agencies outlining a number of management options for ensuring that the Airport redevelopment (including the operational phase of development) would proceed in an environmentally acceptable fashion.

1.4.2 Scope of the Report

The remainder of the report is divided into five chapters. Historical hydrologic, hydrogeologic and water quality information is presented in Chapter 2. The abundance, distribution and leachate attenuation potential of soil and geologic (surficial and bedrock) units within and adjacent to the Airport are discussed in Chapter 3. Results of the hydrometric program are presented and discussed along with groundwater flow patterns in Chapter 4. The results of the water quality sampling program is discussed in Chapter 5. A series of conclusions and recommendations which arose from this study are presented in Chapter 6.

2. HISTORICAL WATER RESOURCE INFORMATION

2.1 General

In order to supplement the existing data base available for the Airport property and to successfully fulfill the objectives of this investigation, the results of previous hydrologic investigations conducted in close proximity to the Airport were evaluated. Those which are directly related are described in some detail below.

2.2 Historical Aquifer Analyses

The hydraulic characteristics for major deep and shallow aquifer systems supplying groundwater to the City of Charlottetown have been assessed by a number of investigators.

In 1966, Brandon conducted an assessment of aquifer hydraulic characteristics for major aquifers within the Winter River Basin(2). The study concluded that aquifer transmissivity values in the Basin ranged from 1.2×10^1 m^3/day/m to 1.89×10^2 m^3/day/m. In 1967, Jones(3) conducted a series of pump tests and sugggested that transmissivity values for the shallow aquifer systems could be as high as 1.84×10^3 m^3/day/m and that storativity values were 2.5×10^{-4}. Further results on the deeper aquifer system revealed that transmissivity and storage values were approximately 9.8×10^2 m^3/day/m and 6.7×10^{-4}, respectively. When these results are converted to Brandon's assumption of a 30.5 metre aquifer, the latter estimated transmissivity value would be approximately 200 m^3/day/m. This test was carried out on a well which was 152 metres deep. Jones, 1967, also concluded that either deep or shallow well systems can supplement the groundwater supply at the Brackley well field and that individual deep wells could be developed to produce yields of approximately 76 l/s.

Since 1967, eight pump tests have been carried out for the Brackley and Union Well Fields as summarized in Table 1. A proper pump test should be carried out for at least 72 hours. Examination of Table 1 shows that only four pump tests meet this criterion. In addition, more confidence can be placed on aquifer hydraulics when all types of interference, such as recharge during the pump test and pumping interference from nearby wells, is removed from the results. The pump tests carried out since 1970 do not permit precise aquifer hydraulic analysis, rather, they can be used to provide order of magnitude estimates of transmissibility and storage which can be used for the design of subsequent pump tests.

TABLE 1 PUMP TEST INFORMATION BRACKLEY AND UNION WELL FIELDS

Date of Pump Test	Well Field Deep or Shallow Well	Duration of Pump Test (minutes)	Pumping Rate (ℓ/s)	Availability and Quality of Basic Data
Sept. 25, 1970	Brackley Shallow Well	315	18[1]	2, 3, 4, 5, 6
Nov. 30 - Dec. 4 1971	Union Deep Well	4320 (72 hour)	11	3, 4, 5, 6
Jan. 4 - 8, 1972	Union Shallow Well	4320	27[1]	4, 5, 6
Feb. 28 - Mar. 3 1972	Union Deep Well	4320	36[1]	2, 4, 5, 6
Jan. 30 - Feb. 2, 1973	Brackley Deep Well	4320	72	2, 4, 5, 6
Oct. 23, 1975	Union Shallow Well	60	8	2, 3, 5, 6
Oct. 23, 1975	Union Shallow Well	150	8	2, 3, 5, 6
Oct. 24, 1975	Union Shallow Well	150	8	2, 3, 5, 6

1. Temporary Pump break down
2. IHD Regional Monitoring wells data available (15 minute interval)
3. Recording precipitation gauge data available
4. Observation well (pumping well plus at least three observation wells)
5. Pumpage from well field for domestic purposes
6. Because water was withdrawn from a series of wells, adjustments for this factor is difficult

In 1977, the Inland Waters Directorate undertook in conjunction with the Prince Edward Island Department of Community Affairs/Environment Division, an assessment of selected aquifers within the Winter River Basin(4,5). The principle objectives of the study were to: (1) identify the analytical techniques which best describe the hydraulic characteristics of aquifers within the Basin; (2)apply the techniques to both existing and derived data; and, (3) outline a future program of study.

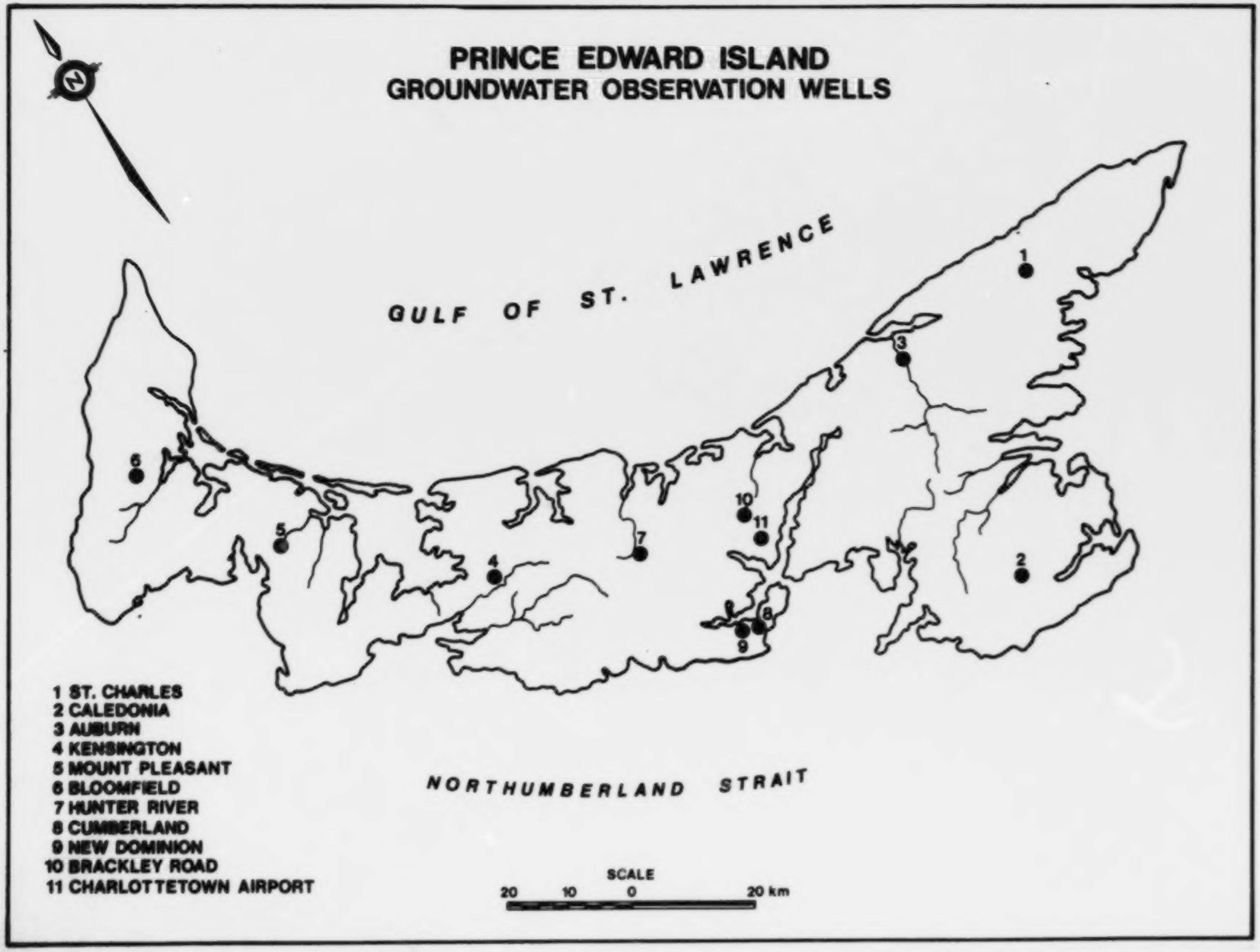
In order to satisfy the above objectives, a series of 9 pumping tests were undertaken at the Union well field involving both the shallow and deep aquifer systems(4). The results of the aquifer hydraulic analysis revealed that the transmissibility estimates for the deep and shallow aquifer systems were comparable to the earlier estimates determined by Brandon and Jones(2,3). The average transmissivity values for the deep and shallow aquifer systems were estimated to be 2.44×10^2 m^3/day/m and 2.44×10^3 m^3/day/m, respectively.

2.3 Historical Observation Well Network

Groundwater levels have been monitored on Prince Edward Island since 1962. The present observation well network consists of 11 wells which are monitored on a continuous basis (Figure 3). Technical difficulties and freezing conditions during winter months have occasionally prevented the establishment of complete records. In addition to the present well network, which is operated by the Inland Waters Directorate, the City of Charlottetown, through the Commissioners of Sewer and Water Supply (COSAWS), maintain groundwater level monitoring equipment in both the Brackley and Union Well Fields.

2.4 Federal-Provincial Hydrometric Program - Winter River

The streamflow regime of the Winter River Basin has been monitored by the Inland Waters Directorate at two locations: Brackley Wells Pumping Station (D.A. = 4.92 km^2 since December, 1968); and, near Suffolk Station below Officers Pond (D.A. = 37.5 km^2 since November, 1967.). The Suffolk Station site is subjected to regulation by a grist/sawmill operation which results in significant hourly and possibly daily streamflow variations over and above natural conditions. The Brackley Wells station is located below the Municipal well field and, as a result, a significant portion of the natural base flow is intercepted before reaching the station. During high water conditions, flow is diverted by an overflow spillway around the hydrometric station.



PRINCE EDWARD ISLAND
GROUNDWATER OBSERVATION WELLS

N
GULF OF ST. LAWRENCE
NORTHUMBERLAND STRAIT
1
2
3
4
5
6
7
8
9
10
11
1 ST. CHARLES
2 CALEDONIA
3 AUBURN
4 KENSINGTON
5 MOUNT PLEASANT
6 BLOOMFIELD
7 HUNTER RIVER
8 CUMBERLAND
9 NEW DOMINION
10 BRACKLEY ROAD
11 CHARLOTTETOWN AIRPORT
SCALE
20 10 0 20 km

FIGURE 3

2.5 Historical Baseflow Study of the Winter River Basin

The Inland Waters Directorate undertook a study of baseflow characteristics of the Winter River Basin and submitted a report to the Prince Edward Island Department of Community Affairs/Environment Division in May, 1974(6). The mean annual baseflow, estimated over a five year period (1968-1972), was found to be 50.0 centimetres and varied from 38.1 to 62.3 centimetres. The variation in monthly mean baseflow ranged from 2.5 to 7.6 centimetres in September and April, respectively. To emphasize the magnitude of the baseflow contribution to total streamflow within the basin, the above mentioned 50.0 centimetres represents approximately 75% of the total streamflow(6).

2.6 Historical Water Quality Data

In support of the International Hydrologic Decade (IHD) program, the Inland Waters Directorate established four water quality monitoring stations on Prince Edward Island in 1967. These stations were located on the Mill, Dunk, Brudenell and North Rivers.

Since 1974, the quality of surface water has been monitored at 21 locations on Prince Edward Island as part of the National Water Quality Monitoring Program. Presently, only 6 stations are monitored throughout the Province. The stations closest to the airport were situated on the North River (Milton Station at the Trans Canada Highway Causeway), the West River (Brookvale, Crosby Mill), the Wheatley River (Wheatley River) and the Hunter River (New Glasgow). During 1977, a water quality sampling station was established by the Inland Waters Directorate on the Winter River near Brackley. Excluding the Inland Waters Directorate sampling stations, there are no known records of surface water quality networks established within the Winter River Basin. However, a number of sporadic analysis have been conducted on groundwater samples obtained from the Brackley, Union, Malpeque and Village of Parkdale pumping stations, as well as on samples obtained from the various distibution systems.

During 1978, the Inland Waters Directorate prepared a report entitled "Water Quality Interpretive Report, Prince Edward Island, 1961-1973"(7). This report presents and discusses the historical water quality data collected throughout the Island as part of the National Water Quality Data Network (NAQUADAT) for the years 1961 to 1973 inclusive. In total, approximately 1600 water samples were obtained from 4 streams, 32 groundwater and 60 estuarian sampling sites and analyzed for as many as 50 parameters.

2.7 Land Use/Environmental Study of Wrights Creek Watershed

During 1977, the Prince Edward Island Department of Community Affairs/Environment Division completed a land use/environmental survey of the Wrights Creek Watershed. The survey defined existing land uses within the Basin and the manner by which land use practices can influence water resources. Sources of pollution were identified and preliminary estimates of pollutant loadings calculated. The report is retained by and available for review at the Prince Edward Island Department of Community Affairs/-Environment Division(8).

2.8 Hydraulic Engineering of Andrews Pond Dam

During 1976 the Prince Edward Island Department of Community Affairs/Environment Division implemented a design study of proposed improvements to the existing Andrews Pond dam.(9) It was concluded that the dam structure could be modified to incorporate a drop-inlet spillway which would provide adequate hydraulic capacity within a desirable range of stage. It was further concluded that adequate minimum levels within the pond could be provided without manual operation as has been the case in the past. Modification costs were estimated at $15,000. In the original concept, no provisions were made for a hydrometric station. The Inland Waters Directorate recommended that a V-notch wier be incorporated into the inlet structure to enable the monitoring of flows in the range, 0-0.3 m^3/sec. Since maximum water levels must be maintained, the dam crest of the dam would have to be increased to avoid overtopping. The Inland Waters Directorate agreed to provide a rating curve for the structure based on model calibration through its Hydraulic Research Laboratory at the National Water Research Institute.

The Province deferred the decision to reconstruct the dam until such time as the dam was acquired by the Province and federal/provincial cost sharing guidelines were mutually decided upon. Cost sharing guidelines were developed early in 1979 and the dam was reconstructed between the fall of 1979 and the spring of 1980. The Project, which cost approximately $44,000, was cost shared (50/50) between the Ministry of Transport and Prince Edward Island Department of Community Affairs/Environment Division. The dam was designed to ensure that the structure could withstand increased flows resulting from alterations to the hydrologic regime because of the Airport redevelopment project.

2.9 The Winter River Basin Study

A federal-provincial preplanning study of the Winter River Basin was completed in December 1976(5). The report defined water resource concerns in the basin and outlined a program to address those concerns. The report addressed a number of water management considerations including: 1) the capacity of the existing well fields to support the increasing future demands by the City of Charlottetown and 2) the land use management concepts and/or additional forms of watershed practices which should be considered to maintain the present water quality regime.

The Winter River Basin study provided significant input to the Charlottetown Airport Water Resources Assessment Program. Since portions of the Charlottetown Airport and proposed expansion areas are located within the Winter River Basin, pertinent information within the Airport property including surficial geology, bedrock geology, groundwater observation well and spring locations, surface water quality stations, and groundwater quality were extracted from the Basin study as described elsewhere in this report.

3. PHYSIOGRAPHY/LEACHATE ATTENUATION

3.1 Soils

The main soil types which can be identified within the Charlottetown Airport property include (in decending proportions) the Charlottetown, Armdale, and Peat soil series(Figure 4).

3.1.1 Charlottetown Soil Series

The Charlottetown soils have developed on surficial till deposits and are derived from soft, micaceous red sandstone and calcareous red conglomerate. The soils are classified as fine sandy loams. The topography, typically associated with these soils, ranges from gently undulating to rolling. The natural drainage characteristics of the Charlottetown soil range from good to imperfect for the upper and internal soil horizons, respectively. The physical and chemical characteristics of the various soil horizons are summarized in Table 2(10).

3.1.2 Armdale Soil Series

The Armdale soils are a mixed group that developed on parent materials ranging from sandy loam to clay loam till(10). These soils range in color from brown to dark brown or black sandy loam to clay loam over dull-brown or brownish-red sandy loam to sandy clay loam. The topography associated with these soils ranges from level to gently undulating. The surface drainage characteristics of these soils are poor while the internal drainage ranges from slow to poor.

3.1.3 Peat Soil Series

Peat soils consist of plant materials, in varying degrees of decomposition, that have accumulated in poorly drained regions including old ponds, lakes and additional depressions. On the Island these deposits are commonly termed as muck, alder, swamp or bog(10).

Peat deposits are reported to be as deep as 12 metres whereas normally the peat complex on the Island ranges from 46 centimetres to approximately 2.1 metres. In the shallower deposits, the organic layer is underlain by soils similar to the poorly drained soils (i.e. Armdale) in the surrounding area.

3.2 Surficial Geology

The glacial drift deposits associated with the Charlottetown Airport can be divided into two main groups; glacio-fluvial deposits and glacial tills (ground moraine and ablation moraine)(11).

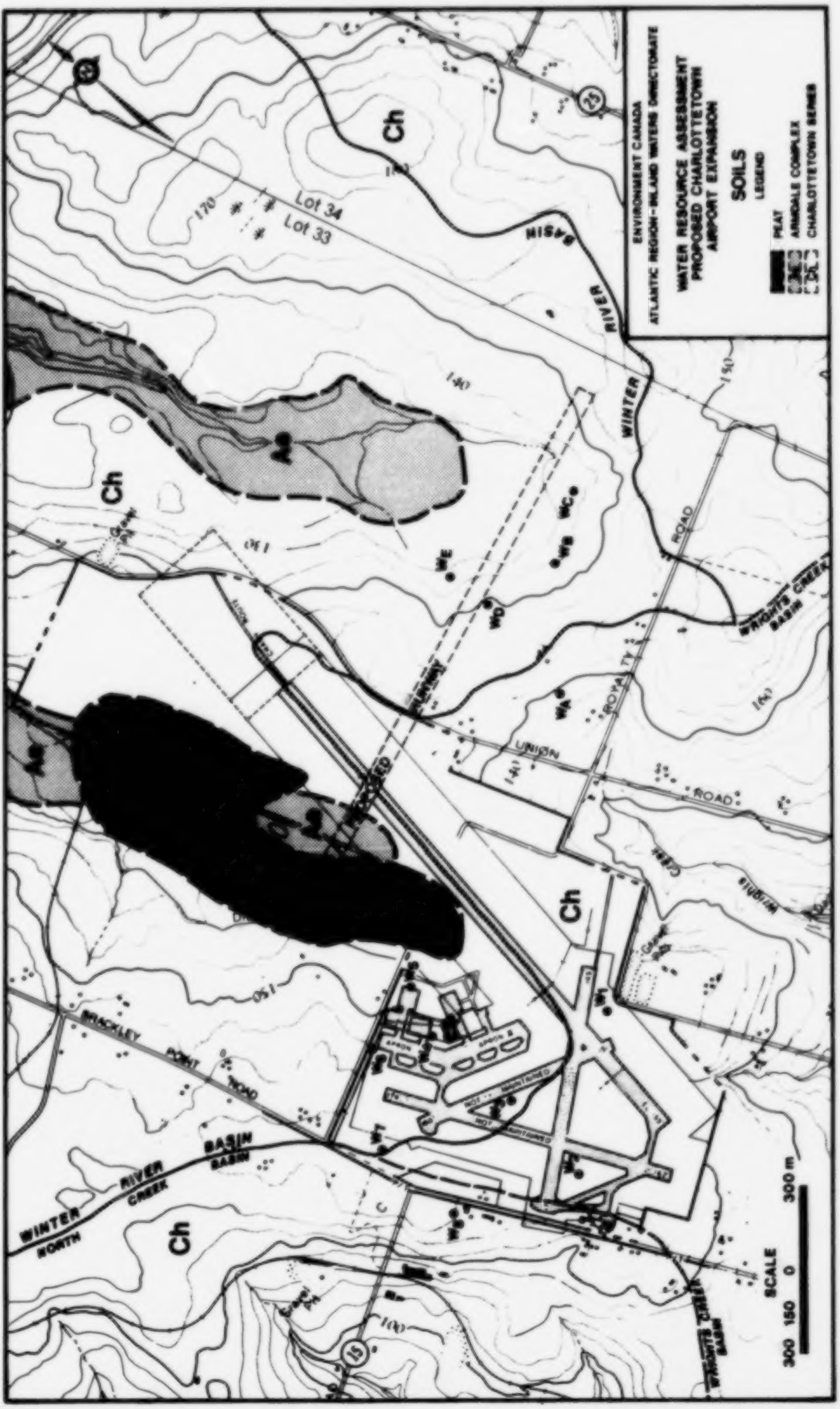

ENVIRONMENT CANADA
ATLANTIC REGION - INLAND WATERS DIRECTORATE
WATER RESOURCE ASSESSMENT
PROPOSED CHARLOTTETOWN
AIRPORT EXPANSION
SOILS
LEGEND
PEAT
ARMDALE COMPLEX
CHARLOTTETOWN SERIES
Ch
Ch
Ch
Ch
Lot 34
Lot 33
WINTER RIVER BASIN
WINTER RIVER
NORTH CREEK BASIN
WRIGHTS CREEK BASIN
BRACKLEY POINT ROAD
UNION ROAD
ROYALTY ROAD
15
25
170
140
150
150
160
160
SCALE
300 150 0 300 m

FIGURE 4

Table 2

Physical and Chemical Characteristics of the Charlottetown Soil Horizons

Physical

Horizon	Depth Inches	Gravel %	Sand, %				Silt, %	Clay, %	Texture
			Coarse 1.0-0.5 mm.	Medium 0.5-0.25 mm.	Fine 0.25-0.1 mm.	Very fine 0.1-0.05 mm.	0.05-0.002 mm.	0.002 mm. or less	
Ap	6	0	6.2	15.8	38.4	10.6	20.4	8.4	Fine sandy loam
L-H (A_0)	2-0	0	0	0	0	0	0	0	Fine sandy loam
Ae (A_2)	0-6	4	1.4	8.0	36.1	14.7	31.6	8.2	Fine sandy loam
Bfh (B_1)	6-14	11	1.6	7.7	33.3	14.2	35.0	8.2	Fine sandy loam
Bf (B_2)	14-24	10	2.2	8.2	31.8	15.6	34.0	8.2	Fine sandy loam
C	24	22	1.9	8.7	28.7	15.7	34.6	10.4	Fine sandy loam

Chemical

Horizon	Depth Inches	Hygroscopic moisture %	Loss on ignition %	Organic matter %	pH	Total nitrogen %	Exchangeable bases, %		
							Calcium	Magnesium	Potassium
Ap	6	1.9	-	2.5	6.4	0.18	-	-	-
L-H (A_0)	2-0	8.0	47.6	16.0	3.8	0.98	0.112	0.054	0.041
Ae (A_2)	0-6	0.5	1.0	2.5	4.5	0.05	0.003	0.004	0.005
Bfh (B_1)	6-14	2.5	5.6	0.5	4.9	0.14	0.003	0.003	0.013
Bf (B_2)	14-24	1.4	2.4	-	5.0	0.06	0.003	0.001	0.006
C	24	1.0	0.5	-	4.7	0.02	0.002	0.001	0.005

The three glacio-fluvial units identified (Figure 5) within the Airport property include:

(a) Valleyside kame - This unit consists of sand and gravel materials of varying heights and slopes. This deposit can be observed along the Brackley Point Road northwest of the existing Charlottetown Airport.

(b) Kame complex - This unit is located on the south and southwestern portion of the Airport and is a conical or irregular shaped mound of ice-contact stratified drift, consisting of sands and gravels.

(c) Finally, a glacio-fluvial deposit, which exhibits no distinct morphology, can be observed in the Wrights Creek watershed along the Union Road south of Royalty Road.

Ground moraine tills can be subdivided into two categories: sand-rich and clay-rich tills, both of which occur within the Airport property. In addition, ablation moraine deposits, which are generally considered as a loose sandy till, can be readily observed within both the Airport property and throughout the Wrights Creek watershed.

3.3 Bedrock Geology

The geologic information is based upon the work of Crowl and Frankel, geologic logs obtained from test wells drilled in support of this investigation (see section 4.3.2.) and field observations of the large excavation pit (Norwood Road) located southeast of the Airport. (Figure 1)(11).

The Airport is underlain by one lithologic unit composed of sandstone and mudstone. The amount of sandstone and mudstone present within this unit is approximately 85% and 15%, respectively. The bedrock which underlays the Airport is typically light colored.

Examination of the Norwood Road excavation pit revealed an exposure of approximately 3 metres of highly fractured, fine to medium grained, red sandstone on three of the exposed faces. The sandstone beds varied in thickness from a few centimetres to a few metres and contained massive blocky fractures in most instances. The bedding planes are sufficiently separated to permit good horizontal permeability. The bedding plane fracture openings are generally less than a few millimetres wide, whereas subvertical fractures are less that 5 millimetres.

In support of the water resource assessment program, 16 - 10.16 centimetre diameter test wells were drilled within and adjacent to the Airport property (refer to sections 4.3.2 for a more detailed description of

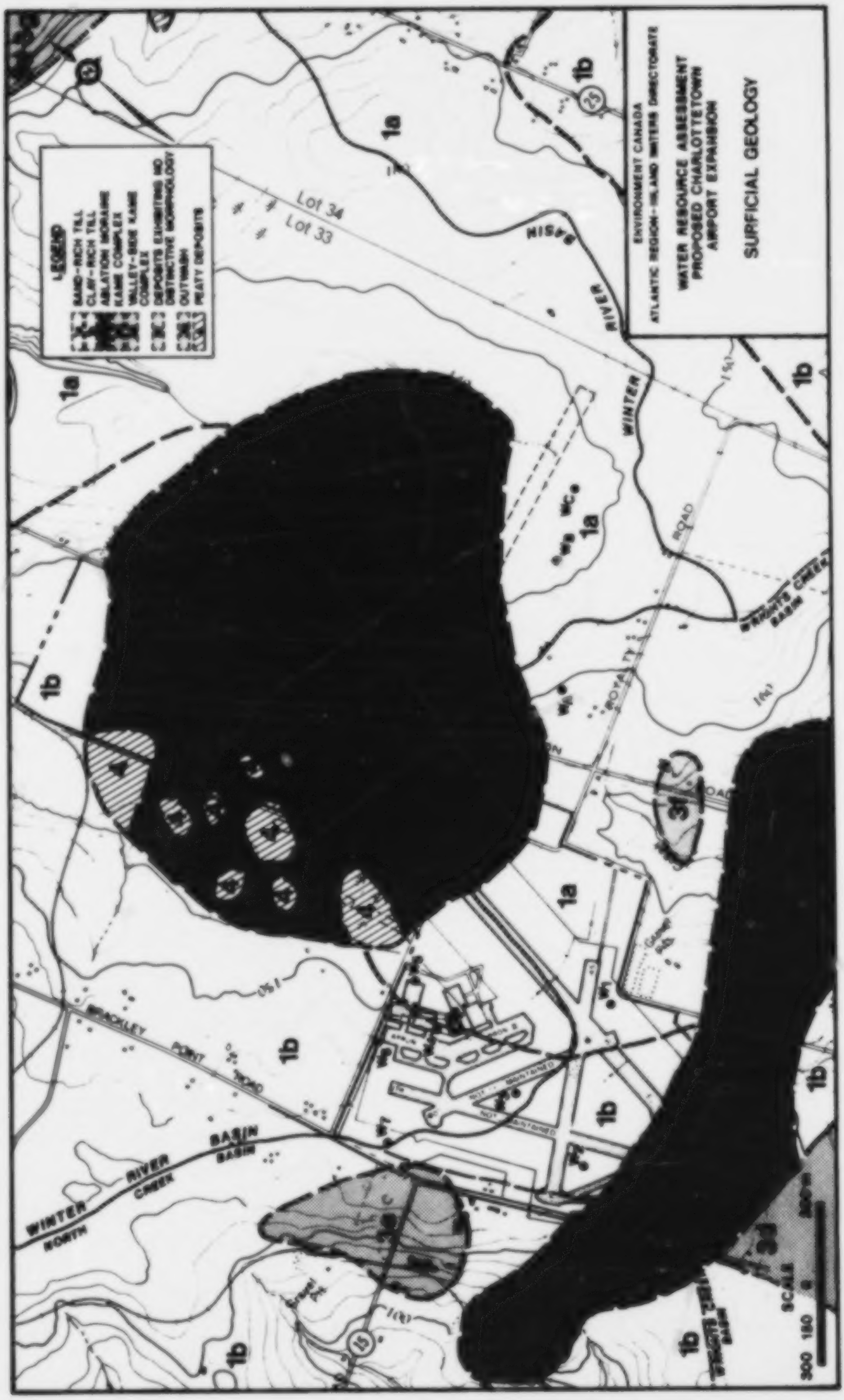

LEGEND
SAND-RICH TILL
CLAY-RICH TILL
ABLATION MORAINE
KAME COMPLEX
VALLEY-SIDE KAME COMPLEX
DEPOSITS EXHIBITING NO DISTINCTIVE MORPHOLOGY
OUTWASH
PEATY DEPOSITS
ENVIRONMENT CANADA
ATLANTIC REGION-INLAND WATERS DIRECTORATE
WATER RESOURCE ASSESSMENT
PROPOSED CHARLOTTETOWN
AIRPORT EXPANSION
SURFICIAL GEOLOGY
Lot 34
Lot 33
1a
1b
3d
WINTER RIVER BASIN
NORTH CREEK BASIN
WRIGHTS CREEK BASIN
BRACKLEY POINT ROAD
ROYALTY ROAD
SCALE
300 150 0 300 m

FIGURE 5

the test wells). Representative geologic logs derived from individual well logs are shown on Figure 6. Generalized geologic cross-sections of the Airport and surrounding area, based on the individual well logs, are shown on Figures 7 and 8. An examination of Figures 6-8 reveals a layer of approximately 3 to 8 metres of red-brown silty sand which overlays a fine-grained, inter-bedded, silty red sandstone.

3.4 Hydrogeological Features/Contaminant Attenuation Phenomena

The potential ability of in situ soil/surficial deposits and bedrock units to attenuate contaminants, and thus afford natural protection to groundwater resources was qualitatively assessed.

The majority of the Airport redevelopment is confined to the Charlottetown soil series which could permit rapid percolation of water to underlying aquifers. This drainage characteristic may result in certain contaminants, such as urea (i.e. nitrate), petroleum products, etc., infiltrating to and thus impairing the water quality of the local aquifers. Attenuative capacity, and hence the ability to adsorb contaminants, is related in part to the amount of fine-grained materials, particularly clay and to a lesser extent, silt-sized materials, which have high surface area/volume ratios. Although the lower soil horizon contains a significant amount of fine-grained material, its ability to adsorb and retain contaminants may be minimal because of low cation exchange potential. This phenomena was observed by officials of the Prince Edward Island Department of Community Affairs/Environment Division after evaluating the cation exchange potential of similar soils located near Charlottetown (Pers. Comm., R. Betcher, P.E.I. Department of Community Affairs/Environment Division). Moreover, contaminants, such as nitrate produced from urea applications, would not be effectively attenuated since nitrate is a mobile compound in soils.

The excavation within or removal of the upper soil horizons during the construction phase will result in the exposure of sand-rich surficial deposits. The potential degree of protection afforded to groundwater resources by these deposits could be minimal suggesting that mitigating measures and/or waste management strategies should be developed and applied during the construction and operational phases of the project.

The major bedrock unit underlying the Airport complex is sandstone with minor amounts of inter-bedded siltstone/mudstone. Francis, 1981,

REPRESENTATIVE WELL LOGS AT CHARLOTTETOWN AIRPORT, P.E.I.

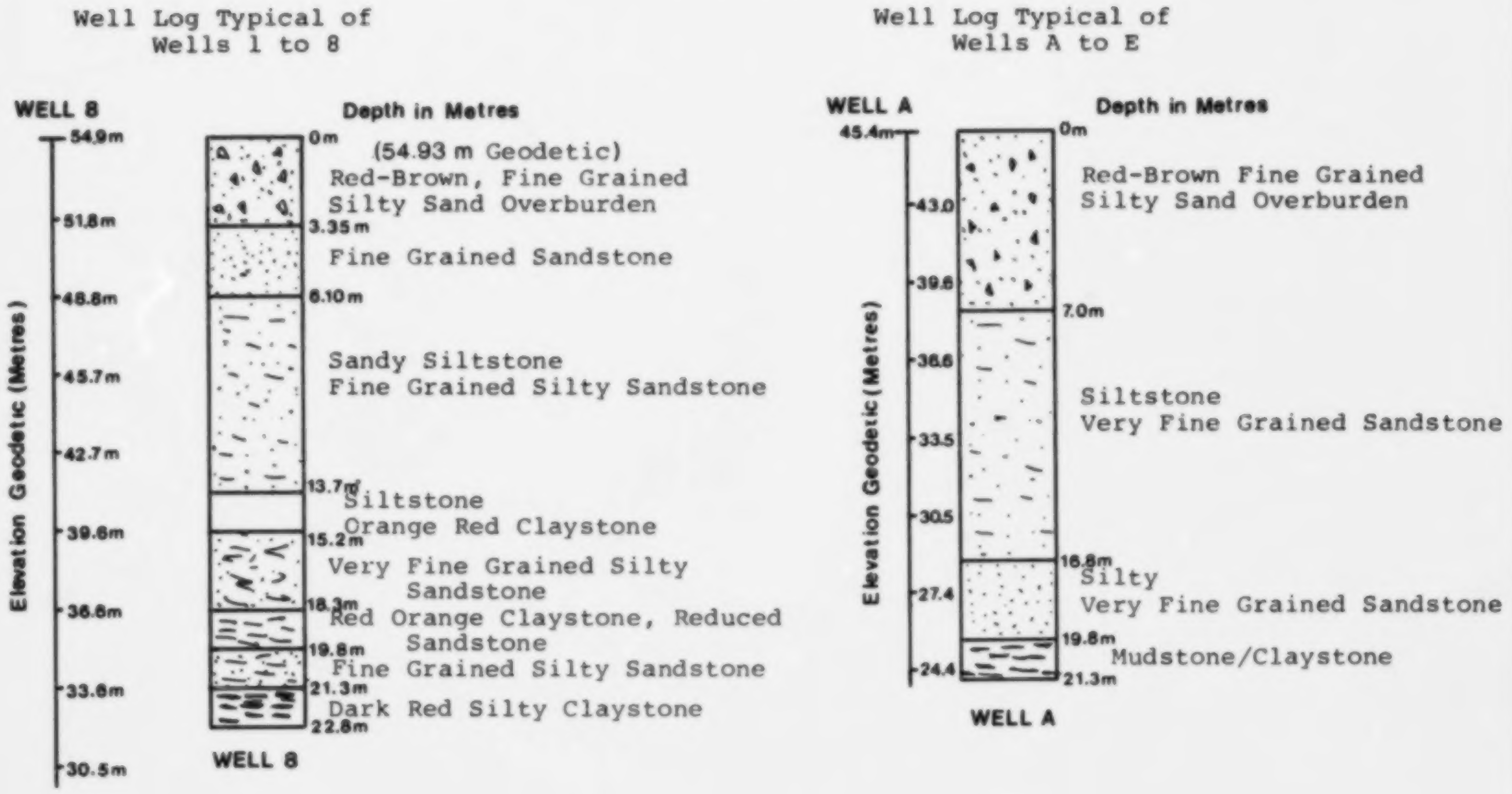

Well Log Typical of Wells 1 to 8
WELL 8
Elevation Geodetic (Metres)
54.9m
51.8m
48.8m
45.7m
42.7m
39.6m
36.6m
33.6m
30.5m
Depth in Metres
0m
(54.93 m Geodetic)
Red-Brown, Fine Grained Silty Sand Overburden
3.35 m
Fine Grained Sandstone
6.10 m
Sandy Siltstone
Fine Grained Silty Sandstone
13.7m
Siltstone
Orange Red Claystone
15.2m
Very Fine Grained Silty Sandstone
18.3m
Red Orange Claystone, Reduced Sandstone
19.8m
Fine Grained Silty Sandstone
21.3m
Dark Red Silty Claystone
22.8m
WELL 8
Well Log Typical of Wells A to E
WELL A
Elevation Geodetic (Metres)
45.4m
43.0
39.6
36.6
33.5
30.5
27.4
24.4
Depth in Metres
0m
Red-Brown Fine Grained Silty Sand Overburden
7.0m
Siltstone
Very Fine Grained Sandstone
16.8m
Silty
Very Fine Grained Sandstone
19.8m
Mudstone/Claystone
21.3m
WELL A

FIGURE 6

GENERALIZED GEOLOGIC CROSS-SECTION

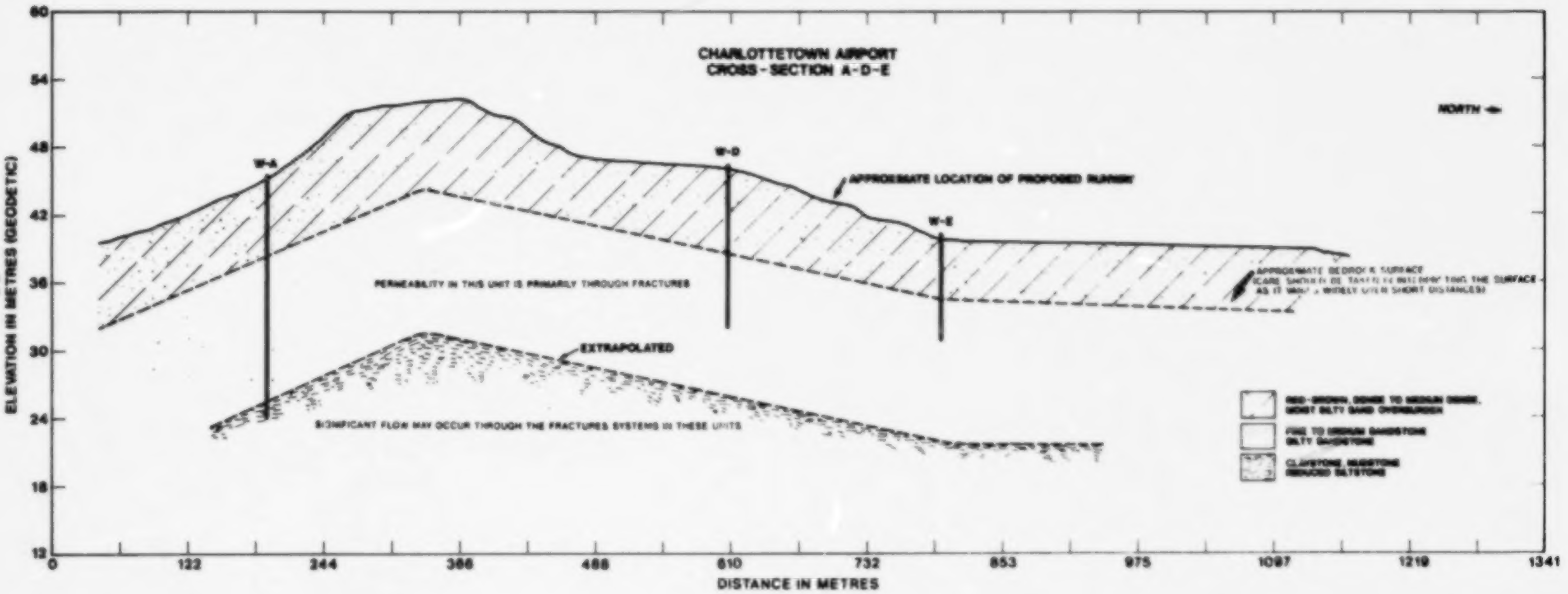

CHARLOTTETOWN AIRPORT
CROSS-SECTION A-D-E
NORTH ←
W-A
W-D
W-E
APPROXIMATE LOCATION OF PROPOSED RUNWAY
APPROXIMATE BEDROCK SURFACE (CARE SHOULD BE TAKEN IN INTERPRETING THE SURFACE AS IT VARIES WIDELY OVER SHORT DISTANCES)
PERMEABILITY IN THIS UNIT IS PRIMARILY THROUGH FRACTURES
EXTRAPOLATED
SIGNIFICANT FLOW MAY OCCUR THROUGH THE FRACTURES SYSTEMS IN THESE UNITS
RED-BROWN, DENSE TO MEDIUM DENSE, MOIST SILTY SAND OVERBURDEN
FINE TO MEDIUM SANDSTONE SILTY SANDSTONE
CLAYSTONE, MUDSTONE REDUCED SILTSTONE
ELEVATION IN METRES (GEODETIC)
60
54
48
42
36
30
24
18
12
0
122
244
366
488
610
732
853
975
1097
1219
1341
DISTANCE IN METRES

FIGURE 7

GENERALIZED GEOLOGIC CROSS-SECTION

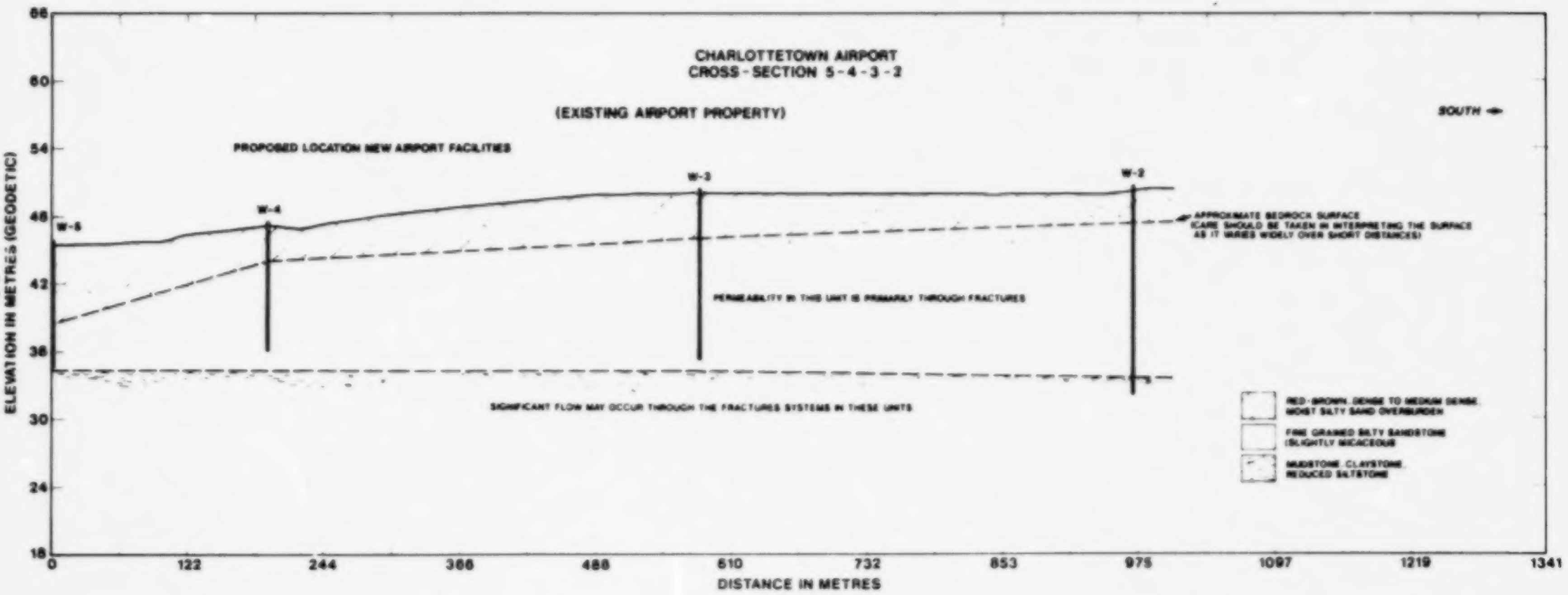

CHARLOTTETOWN AIRPORT
CROSS-SECTION 5-4-3-2
(EXISTING AIRPORT PROPERTY)
SOUTH →
PROPOSED LOCATION NEW AIRPORT FACILITIES
W-5
W-4
W-3
W-2
APPROXIMATE BEDROCK SURFACE
(CARE SHOULD BE TAKEN IN INTERPRETING THE SURFACE
AS IT VARIES WIDELY OVER SHORT DISTANCES)
PERMEABILITY IN THIS UNIT IS PRIMARILY THROUGH FRACTURES
SIGNIFICANT FLOW MAY OCCUR THROUGH THE FRACTURES SYSTEMS IN THESE UNITS
RED-BROWN, DENSE TO MEDIUM DENSE, MOIST SILTY SAND OVERBURDEN
FINE GRAINED SILTY SANDSTONE (SLIGHTLY MICACEOUS
MUDSTONE, CLAYSTONE, REDUCED SILTSTONE
ELEVATION IN METRES (GEODETIC)
66
60
54
48
42
36
30
24
18
DISTANCE IN METRES
0
122
244
366
488
610
732
853
975
1097
1219
1341

FIGURE 8

concluded that both total flux and groundwater velocity at the (Winter River) study site is dominated by the fracture system in both the upper and lower aquifer zones.(18) This condition would create a hydraulic continuum across these stratigraphic units. Therefore, the introduction of pollutants into these bedrock units by Airport operations may result in rapid migration of contaminants over a large area throughout local aquifer systems.

4. SURFACE AND GROUNDWATER HYDROLOGY

4.1 General

The hydrologic component of the assessment program involved: the establishment and monitoring of an observation well network and a temporary hydrometric station; the interpretation of the hydrologic regime of Wrights Creek; and, the establishment of groundwater flow patterns within and adjacent to the Airport property (Figure 9).

4.2 Surface Water Hydrology

As previously mentioned, the existing Airport and proposed redevelopment project are located on a topographic high which drains into three watersheds; North Creek to the west, Wrights Creek to the south and Winter River to the north. The Wrights Creek watershed could be more significantly affected by the redevelopment project since a large proportion of the construction activities would be confined to this watershed and because storm and subterranean drainage systems would divert storm runoff into Wrights Creek.

4.2.1 Streamflow Monitoring

In the original terms of reference, it was envisaged that a permanent hydrometric station would be established on Wrights Creek at Andrews Pond Dam. However, upon further examination of the dam, it became apparent that the existing structure would not provide the sensitivity necessary for a good quality hydrometric station. This, coupled with the facts that the owner manipulated gates during high flow events and the dam showed signs of considerable leakage, provided the basis for not proceeding with the proposal.

A temporary hydrometric station was established on Wrights Creek above Andrews Pond (Figure 9). It was recognized that the hydrometric records produced from this station would only be useful for characterizing seasonal variations in the streamflow regime. Consequently, the primary objective (i.e. to define a flood hydrograph) for establishing this station would not be satisfied.

Commencing on April 1, 1976, a staff gauge was installed and observations were made daily by an area resident. In order to relate stream stage to discharge, a rating curve was established by obtaining a sequence of discharge measurements over a range of flows. The discharge measurements obtained at the site are summarized together with gauge height on Table 3. As can be observed, the relationship between stage and discharge was not

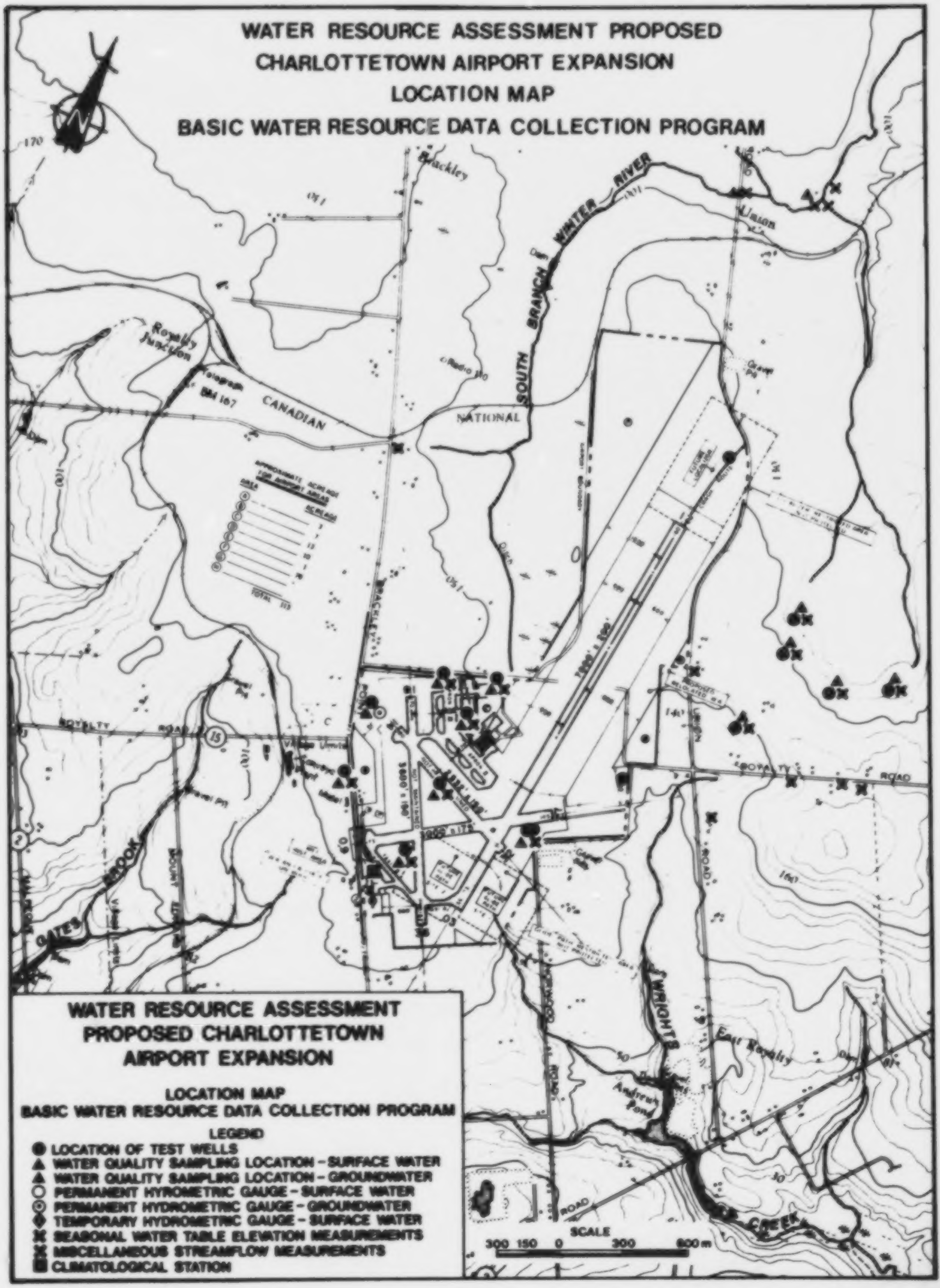

WATER RESOURCE ASSESSMENT PROPOSED
CHARLOTTETOWN AIRPORT EXPANSION
LOCATION MAP
BASIC WATER RESOURCE DATA COLLECTION PROGRAM
Brackley
SOUTH BRANCH WINTER RIVER
Union
Royalty Junction
CANADIAN
NATIONAL
BRACKLEY
ROYALTY ROAD
GATES BROOK
WRIGHTS
East Royalty
Andrews Pond
CREEK
ROAD
WATER RESOURCE ASSESSMENT
PROPOSED CHARLOTTETOWN
AIRPORT EXPANSION
LOCATION MAP
BASIC WATER RESOURCE DATA COLLECTION PROGRAM
LEGEND
● LOCATION OF TEST WELLS
▲ WATER QUALITY SAMPLING LOCATION - SURFACE WATER
▲ WATER QUALITY SAMPLING LOCATION - GROUNDWATER
○ PERMANENT HYROMETRIC GAUGE - SURFACE WATER
⊙ PERMANENT HYDROMETRIC GAUGE - GROUNDWATER
◆ TEMPORARY HYDROMETIC GAUGE - SURFACE WATER
✕ SEASONAL WATER TABLE ELEVATION MEASUREMENTS
✕ MISCELLANEOUS STREAMFLOW MEASUREMENTS
■ CLIMATOLOGICAL STATION
SCALE
300 150 0 300 600m

FIGURE 9

Table 3

WRIGHTS CREEK NEAR AVONLEA ROAD (01CC004)

SUMMARY OF DISCHARGE MEASUREMENTS

Date 1976	Stage metres	Discharge m^3/s	Date 1977	Stage metres	Discharge m^3/s	Date 1978	Stage metres	Discharge m^3/s	Date 1979	Stage metres	Discharge m^3/s
Apr 6	.384	.057	Jan 16	.290	.031	Jan 27	.542	.481	Jan 3	.695	.912
May 12	.424	.071	Feb 23	.256	.045	Jan 30	.408	.091	Jan 23	.369	.051
June 14	.418	.019	Mar 1	.287	.071	Feb 1	.405	.096	Jan 29	.454	.176
Aug 18	.387	.015	Mar 24	.256	.031	Feb 6	.393	.091	Mar 7	.390	.071
Oct 28	.405	.016	Apr 15	.293	.057	Feb 10	.384	.085	Apr 9	.378	.054
Nov 30	.448	.059	May 19	.308	.037	Feb 17	.393	.091			
			May 30	.293	.038	Feb 20	.381	.074			
			May 31	.363	.048	Feb 24	.363	.057			
			July 5	.235	.037	Mar 1	.351	.062			
			July 27	.411	.034	Mar 13	.354	.025			
			Sept 22	.418	.034	Mar 28	.512	.402			
			Oct 21	.485	.096	Mar 30	.436	.127			
			Nov 4	.500	.091	Apr 10	.415	.093			
			Nov 16	.475	.068	Apr 14	.433	.091			
			Dec 15	.475	.071	May 1	.421	.065			
						May 10	.445	.136			
						May 15	.427	.088			
						May 23	.418	.059			
						June 6	.393	.062			
						July 26	.366	.022			
						Aug 28	.378	.018			
						Sept 1	.378	.016			
						Sept 11	.381	.016			
						Sept 18	.357	.015			
						Oct 4	.360	.018			
						Oct 16	.405	.045			
						Nov 15	.375	.023			
						Dec 14	.351	.016			

consistent. There were numerous changes in hydraulic control at the site as a result of natural flood events, bulldozing of the stream, growth of vegetation along the side of and within the streambed itself, and among other factors, children playing and/or moving small rocks in the area of the gauge. Because of the degree of change in the channel regime at the gauge site, the channel was stabilized in July 1977 by placing bags of concrete along the streambed and streambank. Although this measure seemed to be effective at the onset, the control was altered during each high runoff event to a point whereby a new stage-discharge relationship had to be defined. The station was discontinued in April 1979.

Throughout the three years of operation, seven stage-discharge relationships were developed because of control shifts. The quality of record gradually improved over time as the frequency of obtaining discharge measurements was increased.

Plots of daily mean flows over the period of record are shown on Figures 10-13 inclusive.

4.2.2 Extension of the Hydrometric Record

The three years of hydrometric data collected at the Wrights Creek hydrometric station cannot be regarded as being statistically significant. However, there are several methods available which can improve the statistical significance of the data base. These range from hydrologic modelling involving rainfall/snowmelt runoff models to statistical correlation with adjacent watersheds. Because of the small size of the watershed and the method of data collection (i.e. once-a-day reading), it is not possible to extend streamflow data on a daily basis or to employ rainfall/snowmelt runoff models. Nevertheless, it was felt that seasonal (ie. monthly) hydrologic characteristics of Wrights Creek could be determined on the basis of longer term hydrometric records such as those collected on the Winter River.

A linear regression equation was developed between the natural logarithms of the monthly mean discharges recorded on the Winter River near Suffolk (01CC002) and Wrights Creek near Avonlea Road (01CC004). The following equation resulted:

$$\ln X = 1.02363 \ln Y - 2.54939$$

where: Y is the monthly mean discharge in cubic metres per second at hydrometric station 01CC002 on the Winter River near Suffolk, and

SURFACE AND GROUNDWATER HYDROGRAPHS
(1976)

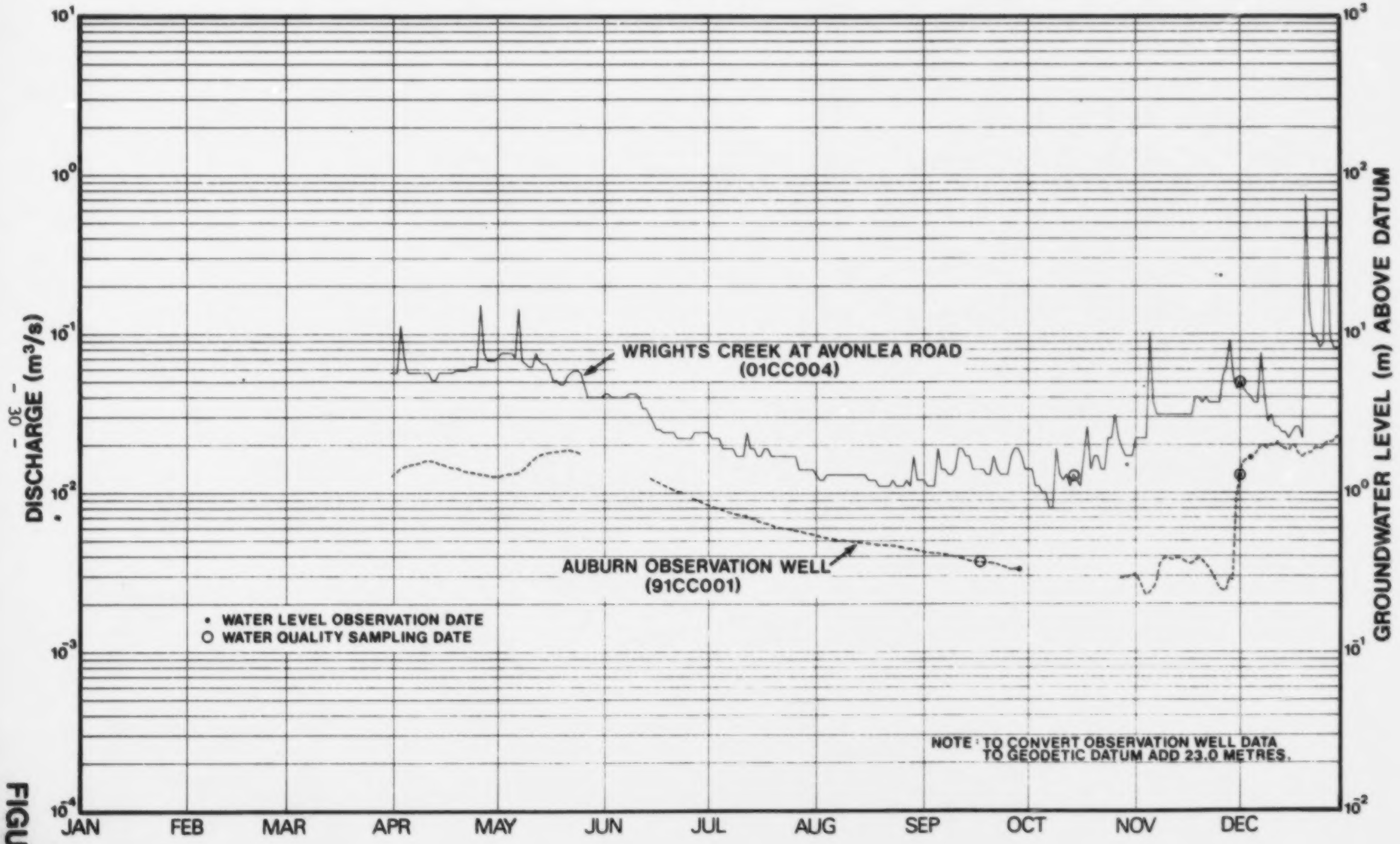
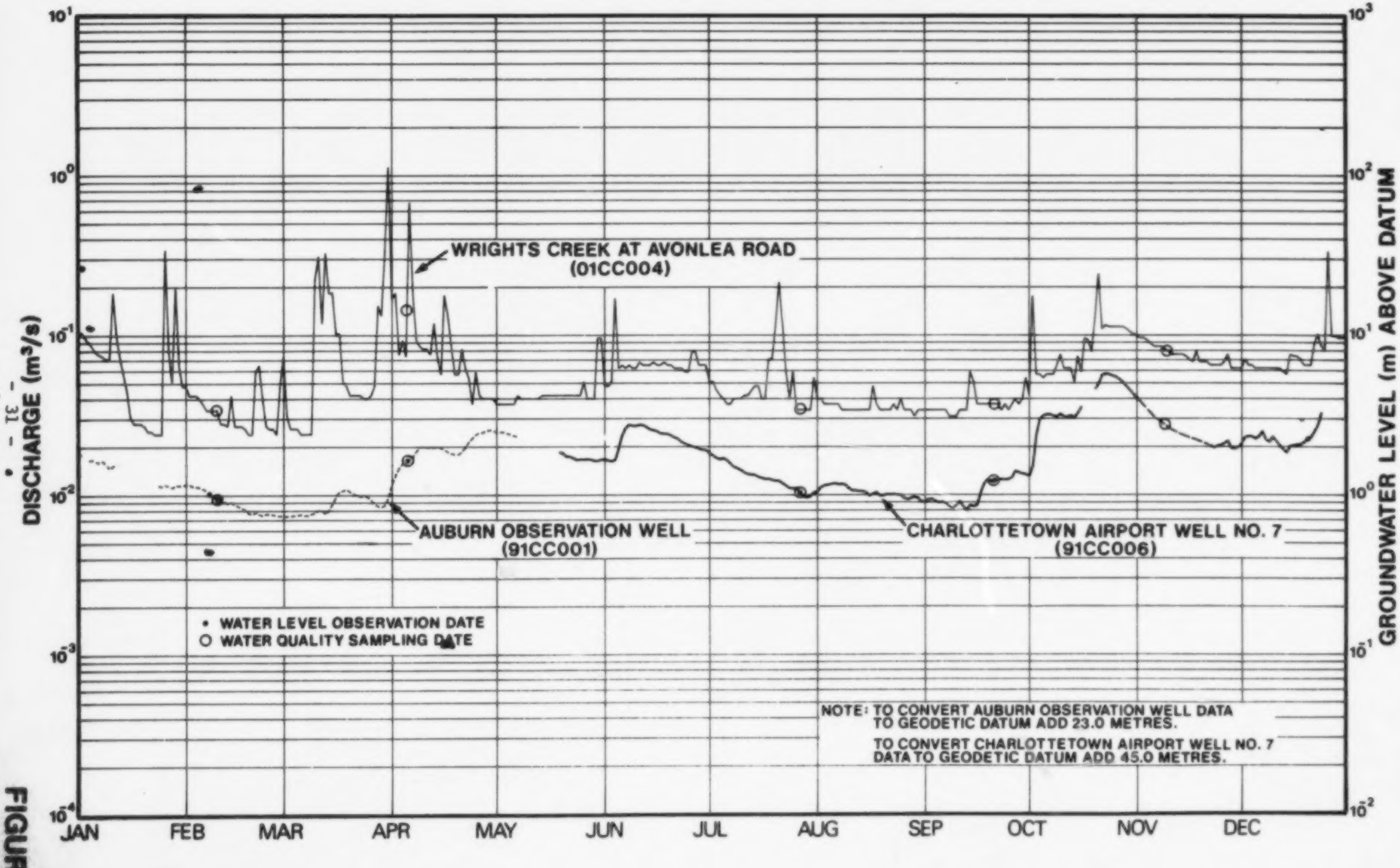


FIGURE 10

SURFACE AND GROUNDWATER HYDROGRAPHS
(1977)



NOTE: TO CONVERT AUBURN OBSERVATION WELL DATA TO GEODETIC DATUM ADD 23.0 METRES.

TO CONVERT CHARLOTTETOWN AIRPORT WELL NO. 7 DATA TO GEODETIC DATUM ADD 45.0 METRES.

FIGURE 11

SURFACE AND GROUNDWATER HYDROGRAPHS
(1978)

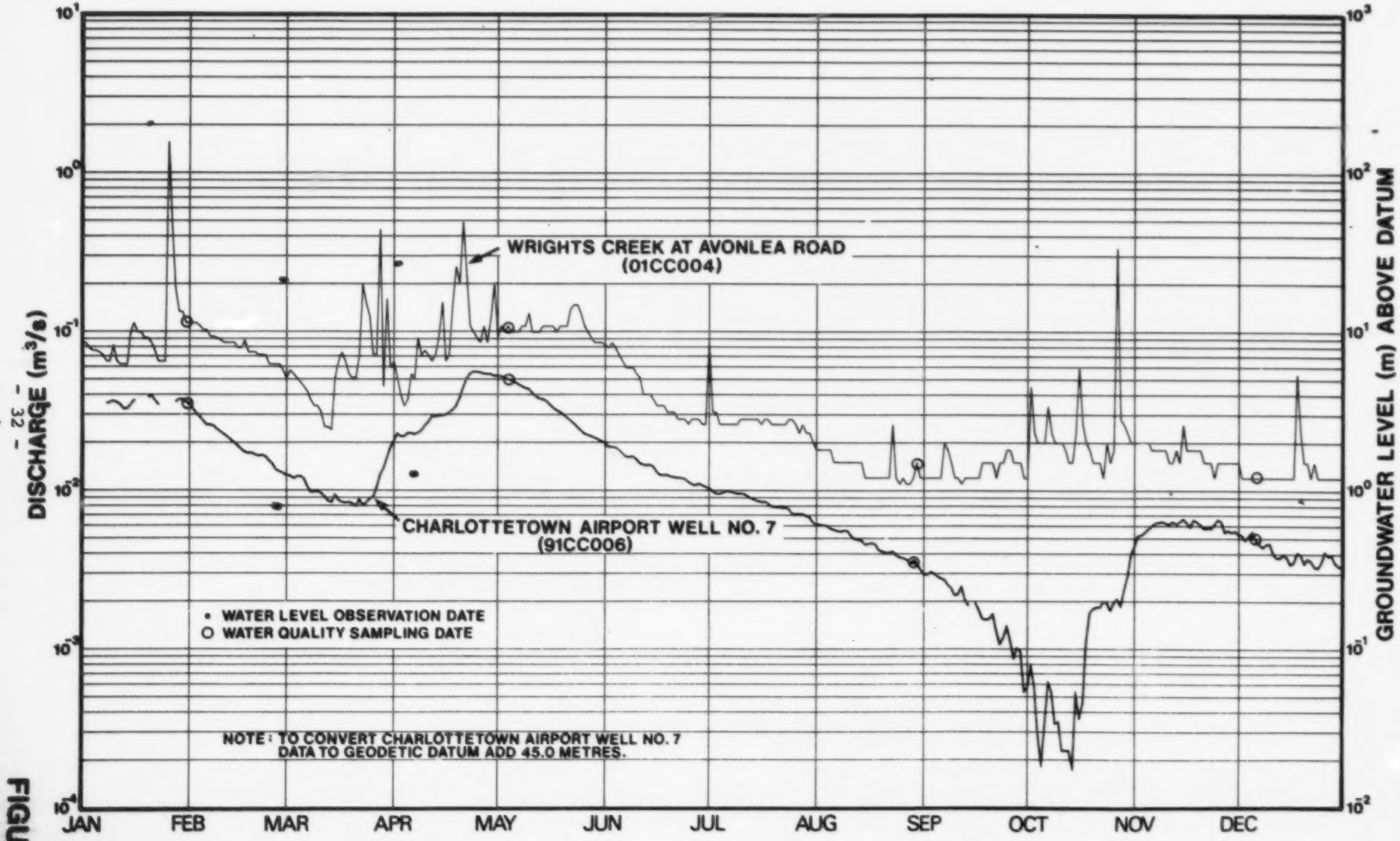
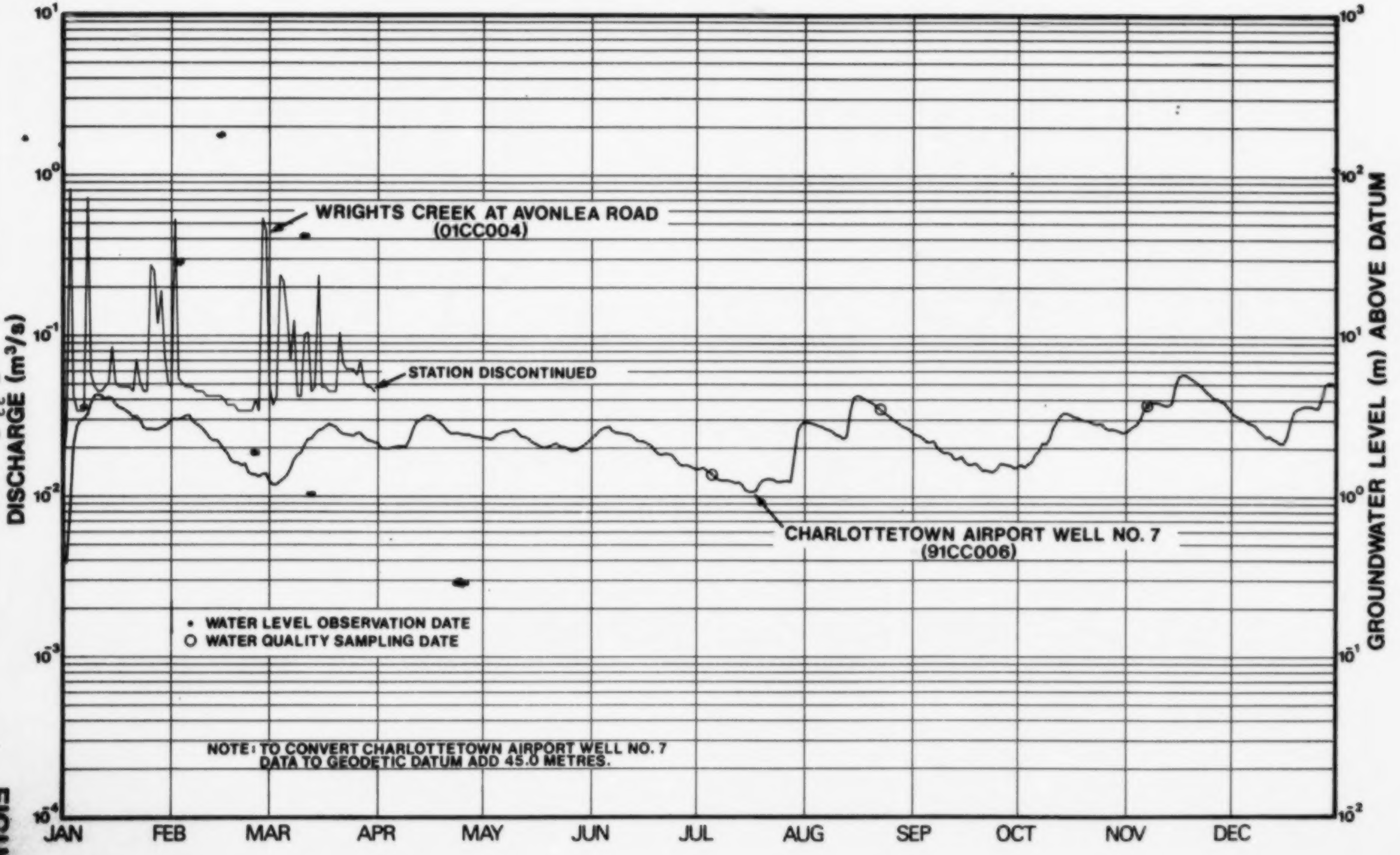


FIGURE 12

SURFACE AND GROUNDWATER HYDROGRAPHS
(1979)



NOTE: TO CONVERT CHARLOTTETOWN AIRPORT WELL NO. 7 DATA TO GEODETIC DATUM ADD 45.0 METRES.

FIGURE 13

X is the monthly mean discharge in cubic metres per second at hydrometric station 01CC004 on Wrights Creek near Avonlea Road.*

The linear regression equation was then used to estimate monthly mean discharge measurements for Wrights Creek near Avonlea Road from April 1979 through March 1980 during which streamflow measurements were not obtained (Table 4). A comparison of recorded and simulated monthly mean streamflow determined at the hydrometric station, Wrights Creek near Avonlea Road, for the period April 1976 through March 1979 is also shown on Table 4.

4.2.3 Seasonal Flow Regime - Wrights Creek

The purpose of this section is to provide an indication of the long term seasonal flow regime of Wrights Creek and to compare the long term flow regime with flows recorded during the study period.

Long term monthly streamflow values for Wrights Creek were estimated using the equation as presented in Section 4.2.2 and the hydrometric record of the station Winter River near Suffolk (01CC002) over the period 1967 through 1979. These data, expressed as a depth (in mm) over the 2.41 km^2 catchment area above the hydrometric station at Wrights Creek, are presented in Table 5.

A comparison (Table 5) of the simulated streamflow over the period, 1967-1979, with that over the study period, 1976-1979, reveals that streamflows were on average about seven percent higher over the study period than normal. On a seasonal basis, runoff during June to September for the study period was slightly lower (about three percent) than the longer term, runoff during October to February for the study period was significantly higher (about 32 percent) than would normally occur (with most of this difference occurring in January) while runoff during March to May for the study period was slightly below normal (about ten percent).

The difference between the short and long term runoff values can be accounted for on an annual basis by examining precipitation differences. Precipitation data recorded at Charlottetown Airport are presented in Table 5 on a monthly basis for both the period April 1976 to March 1979 and the period November 1967 to December 1979. These data indicate that the mean

---

*correlation coefficient = .94
standard error of estimate of the natural logarithm of X = .26968

Table 4

SIMULATED MONTHLY MEAN DISCHARGE FOR HYDROMETRIC STATION (01[illegible])

WRIGHTS CREEK NEAR AVONLEA ROAD

MONTH Date 1976	Recorded (m^3/s)	Simulated (m^3/s)	MONTH Date 1977	Recorded (m^3/s)	Simulated (m^3/s)	MONTH Date 1978	Recorded (m^3/s)	Simulated (m^3/s)	MONTH Date 1979	Recorded (m^3/s)	Simulated (m^3/s)	MONTH Date 1980	Recorded (m^3/s)	Simulated (m^3/s)
April	.064	.070	January	.077	.051	January	.147	.166	January	.155	.085	January	-	.079
May	.063	.060	February	.025	.029	February	.084	.068	February	.091	.081	February	-	.080
June	.032	.038	March	.139	.086	March	.076	.055	March	.079	.120	March	-	.041
July	.018	.025	April	.104	.110	April	.113	.160	April	-	.075			
August	.012	.017	May	.066	.058	May	.107	.109	May	-	.059			
September	.015	.017	June	.067	.037	June	.065	.043	June	-	.042			
October	.015	.016	July	.055	.027	July	.028	.029	July	-	.038			
November	.018	.046	August	.036	.031	August	.016	.017	August	-	.064			
December	.093	.099	September	.037	.031	September	.014	.016	September	-	.054			
			October	.081	.091	October	.032	.029	October	-	.063			
			November	.076	.071	November	.017	.020	November	-	.101			
			December	.082	.077	December	.014	.017	December	-	.093			

Table 5

COMPARISON OF SHORT AND LONG TERM MAJOR HYDROLOGIC FACTORS IN THE WRIGHTS CREEK BASIN

	LONG TERM PERIOD (1967-1979)				SHORT TERM (STUDY) PERIOD (1976-79)		
	Precipitation mm	Pan Evaporation mm	Runoff mm	Groundwater †	Precipitation mm	Pan Evaporation mm	Runoff mm
January	116.6		70.0	+ ‡	148.0		125.
February	91.9		57.7	+ ‡	92.5		70.9
March	101.3		85.6	+ ‡	82.7		105.6
April	86.1		129.0	+ ‡	79.2		101.1
May	90.4	78.1*	102.2	–	92.5	79.8*	78.9
June	81.7	85.6*	50.5	–	80.7	98.1*	51.6
July	89.2	103.5	35.6	–	129.0	112.2	37.8
August	88.8	89.7	28.9	–	89.2	97.5	22.2
September	82.1	63.3	24.7	+	114.	70.4	23.7
October	122.7		37.8	+	165.		51.1
November	120.2		47.3	+	99.7		47.3
December	145.5		62.2	± ‡	146.		70.
Total Mean	1216.5	420.2	731.5		1318.5	458.0	785.2

* Incomplete data for period

† + = net recharge ; – = net discharge

‡ Runoff is effected by the storage or melt of snow and the infiltration to groundwater

annual total precipitation over the longer term was slightly (about eight percent) lower than that which occurred during the study period.

Explanations of differences between the short term and long term runoff values on a monthly or seasonal basis are not as easily explained. While it was shown that throughout the summer season (June through September) runoff was slightly lower than for the longer term, summer season precipitation during the study period was higher (about 21 percent) than for the longer term. Approximately half of this discrepancy can be accounted for by greater potential evapotranspiration during the study as opposed to the long term period. This is evident in the pan evaporation data, collected at Agriculture Canada's experimental farm, which are summarized in Table 5. While it was shown that runoff for the months of October through February in the study period was significantly higher than would normally occur, this can only be partially explained by the roughly nine percent higher precipitation inputs. For the spring runoff months of March through May, total precipitation inputs during the study period were slightly lower (about eight percent) than for the longer period. This appears to be reflected in the slightly below normal runoff recorded during the study period.

An overall water balance of the various inputs and outputs based on total precipitation, pan evaporation and runoff data is presented in Table 5 for the short term and long term periods of record. Results indicate that approximately five percent of inputs are unaccounted for in the evaporation or runoff data. Since these differences are insignificant when compared with the accuracy with which streamflow, precipitation and evapotranspiration can be measured or estimated, it is difficult to conclude that any significant amount of water was being contributed to regional groundwater flow.

4.3 Groundwater Hydrology

4.3.1 General

The potential introduction of contaminants into local groundwater flow systems as a result of construction and/or the operation of the Airport facilities is a major concern of the Prince Edward Island Department of Community Affairs/Environment Division. This section of the report describes the establishment of the observation well network and presents an interpretation of groundwater flow patterns within and adjacent to the Airport complex.

4.3.2 Establishment and Monitoring of the Observation Well Network

In support of the water resources assessment program, the Ministry of Transport, under contract, drilled 16-10.6 centimetre diameter test wells using specifications agreed to by the Prince Edward Island Department of Community Affairs/Environment Division and the Inland Waters Directorate (Figure 14). The observation wells were established to: provide geologic information within and adjacent to the Airport property; enable determination of groundwater flow directions; and, permit the collection of groundwater quality samples.

Test drilling was conducted in two phases. Phase I drilling involved the establishment of 13 wells during 1976, 8 of which were located on Airport property and the remaining 5 wells were drilled on adjacent private lands situated on the periphery of the Airport. Phase II involved the installation of 3 additional test wells during 1979. The Phase I wells were drilled by a cable tool rig whereas the Phase II wells were installed by air rotary equipment.

The wells, which were drilled to the first water bearing zone, ranged in depth from approximately 9 to 26 metres. Approximately 6 metres of steel casing, fitted with a drive shoe, was installed in each well to ensure aquifer stability and capped to prevent surface water contamination. Drilling was supervised by a geologist with the Prince Edward Island Department of Community Affairs/Environment Division. During the drilling program, samples were obtained at 1.5 metre intervals to describe the various lithologic units. Vertical and horizontal coordinates were established at each well by field survey techniques.

Water level observations were obtained from the test wells on 11 occasions between September 28, 1976, and November 9, 1979, to determine seasonal fluctuations within wells and, if present, seasonal variations in the groundwater flow regime. A number of private water table wells were monitored on one occasion to enable interpolation of water table contours to areas located outside the Airport property.

Water table measurements were taken using an electric tape drop and referenced to a point on the casing previously surveyed. A summary of the data, reduced to metres - Geodetic, is contained on Table 6, together with some pertinent information on each well.

Table 6

SUMMARY OF WATER TABLE ELEVATIONS

Well No.	Well[5] Log (m)	Measured From Top of Casing[6] (m)	First[5] Water Occurrence (m)	Elevation Top of Casing (m - Geodetic)	Geodetic Water Levels (m)										
					28-09-76	29-11-76 to 01-12-76	03-12-76	07-02-77 to 08-02-77	04-04-77	26-07-77	20-09-77	31-10-77	19-12-77	28-08-78 to 29-08-78	06-11-79
W-1	16.8	13.93	14.6	45.03	38.03	39.39[4]	38.74	-[1]	35.83	32.99	38.13	37.45	38.44	-[1]	38.57
W-2	18.3	10.14	14.6	57.69	39.02	-	42.08	38.49[4]	40.11	39.20	40.43	41.38	40.67	38.37	42.19
W-3	13.7	15.34	12.5	51.17	41.74	44.39[4]	44.79	41.92	42.03	42.39	42.95	45.81	42.41	41.04	44.03
W-4	12.8	11.29	11.6	47.94	41.99	42.96	43.08	41.78	42.20	42.13	42.59	43.64	43.04	41.50	42.71
W-5	9.1	10.68	8.8	46.52	40.23	41.32	41.88	40.02	40.57	40.23	40.83	42.97	41.24	39.66	42.38
W-6	12.2	12.59	11.6	48.52	41.99	42.79[4]	42.84	42.18	42.29	42.30	42.50	42.93	42.66	41.90	42.67
W-7	16.8	17.44	15.5	57.40	45.18	47.36[4]	48.48	45.84[2]	46.33	46.12[2]	46.21[2]	49.49	47.16	45.36	48.47
W-8	22.9	25.50	24.1	55.77	37.68	39.04	39.56	38.07[4]	38.80	38.23	38.45	39.76	39.16	37.57	39.63
W-9	21.9	-	21.4	45.24	-	-	-	-	-	-	-	-	-	-	34.25[7]
W-10	12.2		11.9	36.74	-	-	-	-	-	-	-	-	-	-	30.05[7]
W-11	16.8	-	12.2	44.52	-	-	-	-	-	-	-	-	-	-	37.67[7]
W-A	21.3	22.73	21.9	45.93	-	35.71	36.29	34.91[4]	35.54	34.78	-	37.41	36.20	33.63	36.59
W-B	10.7	11.07	9.4	43.12	-	38.45	38.83	38.08[4]	38.65	37.94	-	40.57	39.18	37.04	39.57
W-C	11.9	11.98	10.7	42.10	-	38.78	39.26	38.76[4]	39.92	38.50	-	40.91	-[3]	-[3]	-[3]
W-D	14.3	14.45	13.1	47.10	-	37.54	38.14	36.90[4]	37.24	36.80	-	39.93	38.12	35.95	38.51
W-E	9.1	8.96	9.1	40.42	-	37.56	38.13	36.84[4]	37.28	36.73	-	39.74	38.01	35.90	38.33

Notes:

1. Dry Well
2. Elevation taken directly from Recorder Chart
3. Well permanently sealed and buried
4. Mean of 2 recordings
5. Obtained from Well Drillers' logs
6. Measured by Inland Waters Directorate
7. New well drilled February 27, 1979

4.3.3 Continuous Groundwater Level Observations

A continuous groundwater observation well was established at well 7 (Figure 14) in February 1977. The objective of establishing a continuous record of groundwater stage was to examine seasonal variations in water levels and to assist in the interpretation of the miscellaneous measurements collected from the remaining test wells.

Groundwater stage was recorded on a chart by a Leopold-Stevens A71 Analog recorder. The scales of the chart were 1 cm = 0.25 metres and 3 cm = 1 day. The recorder was checked on a monthly basis to ensure that it was operating properly. Due to initial problems, the gauge did not produce a record until May 19, 1977.

Data from the gauge covering the period May 19, 1977 to December 31, 1979, are presented in Figures 10-13 inclusive. As can be seen, there are several periods for which records are missing primarily due to instrument malfunction. To provide a more complete record of groundwater fluctuation prior to May 19, 1977, data collected from the Auburn observation well are included on Figure 10-11 for the period April 1, 1976 - May 4, 1977.

4.3.4 Groundwater Flow Patterns

The establishment of groundwater contours and flow directions within and adjacent to the Airport property was an integral component of the water resource assessment program. A potentiometric map of the airport and surrounding environs showing groundwater contours and resulting flow directions serves a number of useful purposes. Perhaps the most valuable use of such maps is to enable the determination of the direction and movement of existing and potential contaminants introduced by Airport activities into local groundwater flow systems. The following criteria listed in decreasing importance were used to finalize the groundwater contour and groundwater flow direction maps.

(a) The most important information used to construct the final flow nets was the water level data collected, on various occasions, from the Airport wells (1-11, A-E)

(b) To extrapolate the groundwater contours to areas on the periphery of the Airport, elevations of assumed discharge areas (i.e., sinks where the water table is known to be high such as swamps, springs and excavations) were obtained from 1:2400 topographic maps, 1:10,000 orthophoto maps and 1:12,000 topographic maps and incorporated into the groundwater contour map

(c) To supplement items (a) and (b) above, additional water table measurements were obtained from private wells located adjacent to the Airport. Water table elevations from private wells were integrated into the final flow nets if drillers' records confirmed that the wells penetrated and received water from the first water bearing zone

(d) In areas devoid of data, water table contours were adjusted in accordance with topographic features.

The procedures used in establishing the water table contour maps and flow nets from the water level data were as follows:

(a) all groundwater depths were adjusted to geodetic datum

(b) the adjusted data were then plotted on a 1:2400 scale base map

(c) water table elevations between the respective wells were interpolated and points of equal elevation joined to establish the water table contours

(d) from these water table contour maps, the groundwater flow patterns were obtained

Although water level data were obtained from the various wells on 11 occasions, only two groundwater contour maps are included in this report (Figures 14 and 15). There were a number of reasons for presenting only two groundwater contour maps including:

(a) the basic flow patterns were representative of flow nets constructed for each water level survey particularily within the immediate areas adjacent to wells 1-8 and A-E, inclusive

(b) the water level data obtained in December of 1977 included a number of private dwellings and discharge areas which both supplemented the basic flow patterns in the Airport area and also expanded them to provide information on groundwater movements in areas removed from the Airport wells

(c) the November 1979 flow net was constructed from water levels obtained from the three new wells numbered 9 to 11, (Figure 1). Water levels collected from these wells would therefore illustrate, more precisely, groundwater flow directions between the two observation well networks (1-8, A-E). This flow net was adjusted to reflect the general flow directions determined on the basis of water levels previously obtained (see b above)

(d) the groundwater contour maps are reflective of the seasonal influence on groundwater flow directions within and adjacent to the airport property. As such, these flow diagrams can be considered, because of proportional water level fluctuations within and between wells throughout the period of study, representative of seasonal variations in flow directions which correspond to major hydrologic events. (Fig. 14, 15)

Referring to Figures 14 and 15, it can be seen that the majority of the water table contour lines are dashed, whereas smaller portions are solid. Dashed lines indicate areas where, because of the positioning of the well network, interpretation of the groundwater flow pattern is uncertain and may therefore be subject to alternative interpretations. Solid lines, on the other hand, denote areas where there is greater certainty in the flow net construction.

The groundwater contour maps are similar with only slight variations in groundwater flow directions. As can be observed the only differences between the maps is, the groundwater divides do not, at certain locations, coincide.

The majority of contaminants applied to the proposed runway and service access road will be directed, via the groundwater flow system, into the Winter River Basin. Alternatively, contaminants associated with the majority of the remaining Airport facilities (apron, taxiways, terminal building, public and employee parking lot, fire training, etc.) will flow into Wrights Creek, either directly through the existing or proposed drainage network or indirectly through groundwater flow systems. The combined services building and solar energy facility lies more or less on the groundwater divide between Wrights Creek and Winter River Basin. The implications of contaminant migration patterns in the groundwater flow system from the proposed Airport expansion are described in Chapter 5.

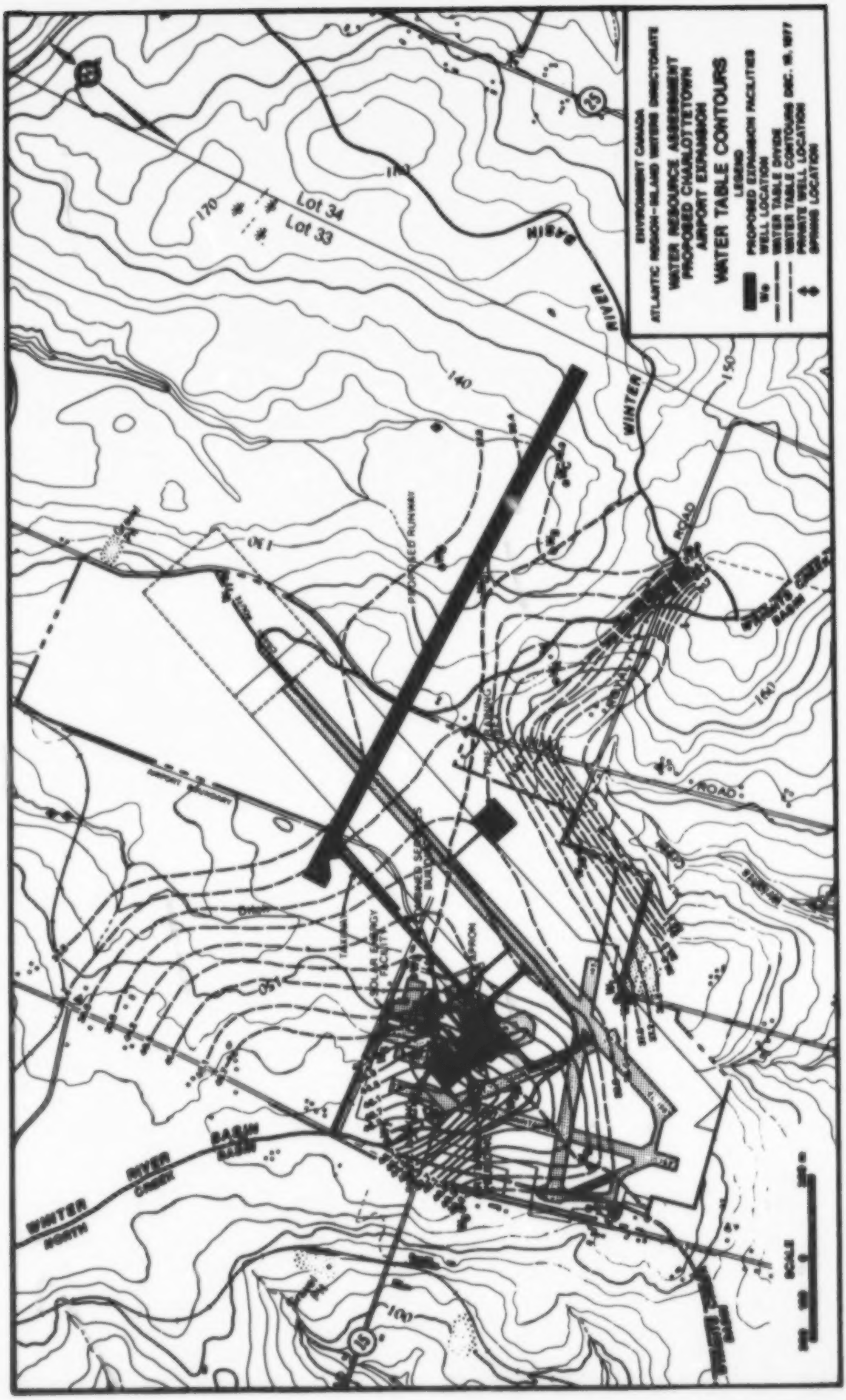

ENVIRONMENT CANADA
ATLANTIC REGION—INLAND WATERS DIRECTORATE
WATER RESOURCE ASSESSMENT
PROPOSED CHARLOTTETOWN
AIRPORT EXPANSION
WATER TABLE CONTOURS
LEGEND
PROPOSED EXPANSION FACILITIES
WELL LOCATION
WATER TABLE DIVIDE
WATER TABLE CONTOURS DEC. 15, 1977
PRIVATE WELL LOCATION
SPRING LOCATION
Lot 34
Lot 33
170
140
150
160
100
WINTER RIVER BASIN
NORTH WINTER RIVER BASIN
PROPOSED RUNWAY
ROAD
SOLAR ENERGY FACILITY
APRON
TAXIWAY
SCALE
25
2

FIGURE 14

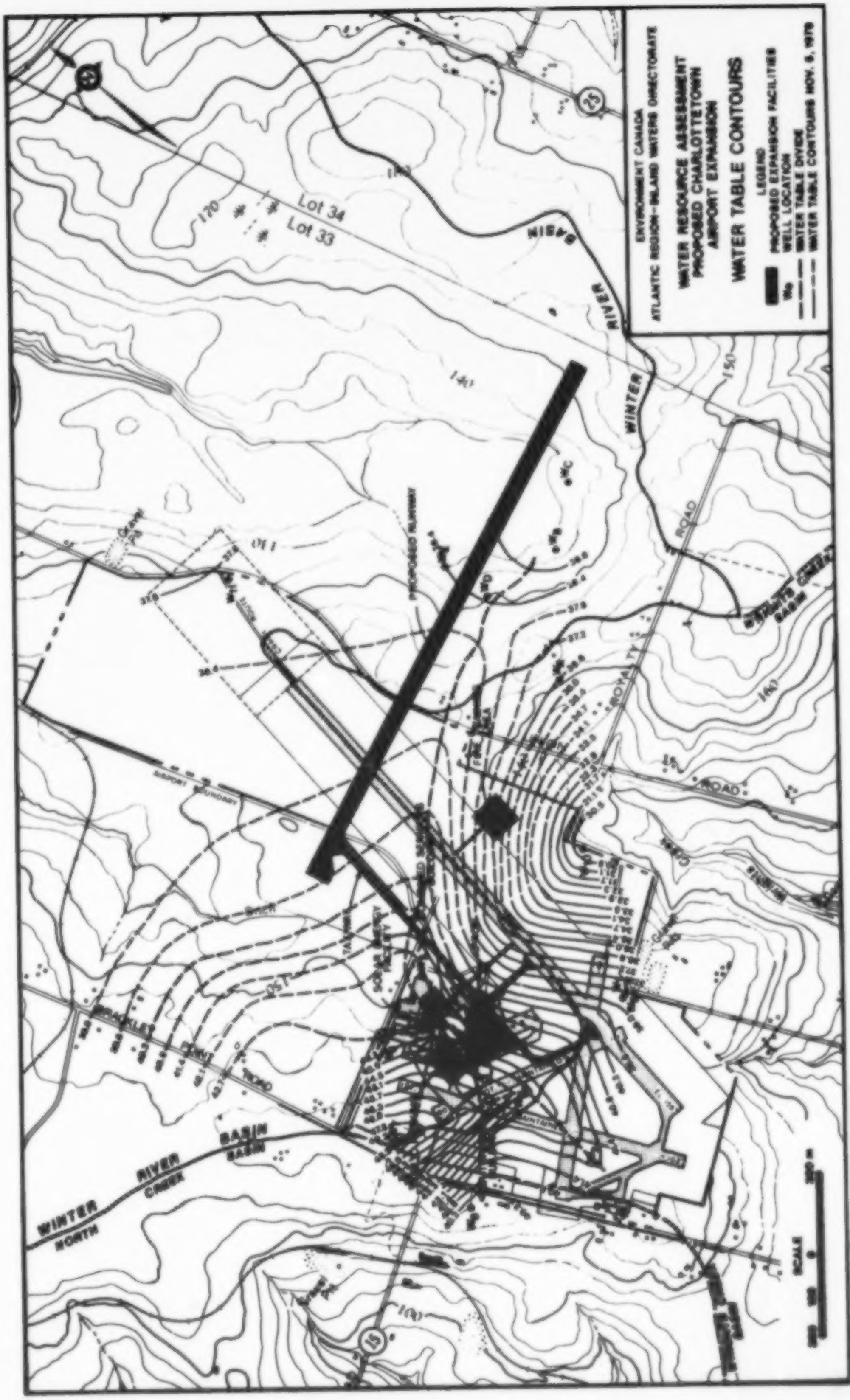

ENVIRONMENT CANADA
ATLANTIC REGION–INLAND WATERS DIRECTORATE
WATER RESOURCE ASSESSMENT
PROPOSED CHARLOTTETOWN
AIRPORT EXPANSION
WATER TABLE CONTOURS
LEGEND
PROPOSED EXPANSION FACILITIES
WELL LOCATION
WATER TABLE DIVIDE
WATER TABLE CONTOURS NOV. 6, 1979
Lot 34
Lot 33
170
140
150
160
100
WINTER RIVER BASIN
WINTER RIVER BASIN
NORTH CREEK BASIN
BRACKLEY POINT ROAD
ROYALTY ROAD
PROPOSED RUNWAY
AIRPORT BOUNDARY
SCALE

FIGURE 15

5. WATER QUALITY

5.1 General

The primary objective of the water quality component of the assessment program was to establish baseline water quality information within and adjacent to the Airport redevelopment. This would indicate the manner by which the existing Airport operations were influencing water quality and would also provide baseline information from which subsequent changes to water quality following redevelopment could be determined.

The water quality component of the water resources assessment program consisted of three distinct phases: the initial phase in which sampling stations were selected; Phase II which involved water quality monitoring; and Phase III which involved a modest sampling program concurrent with construction activity.

The initial phase of the program which was implemented during the period September 1976 - April 1977 commenced after the observation wells were drilled. This phase was intensive in that all sites (observation wells, surface waters and municipal pumping stations) were sampled and analyzed for a wide range of parameters. During this phase, sampling procedures were developed.

The second phase of the water quality sampling program was conducted over the period from May 1977 to October 1978, inclusive. In May (1977) the Inland Waters Directorate, in conjunction with the Prince Edward Island Department of Community Affairs/Environment Division, selected and monitored a reduced number of wells. Specifically, wells 2, 5 and 8 were maintained and monitored because: (a) each well was situated in a differing groundwater flow direction from the existing Airport, and (b) the direction, movement and magnitude of contaminants from the existing Airport could be monitored in these wells. Wells B and E were maintained to enable the determination of the movement and direction of contaminants in the groundwater flow system prior to and following runway completion. It was further recognized that, when comparing water quality within and between wells, subtle chemical differences were observed and based on the analysis of Phase I data, it was concluded that wells B, E, 2, 5 and 8 would provide the most representative water quality information. In addition, the three municipal pumping stations and the various streams draining the airport property were monitored during this period.

The third phase of the water resources assessment study which was conducted from January 1979 to March 1980, was designed to monitor, at a reduced number of stations, possible changes in water quality resulting from initial construction activities. Surface waters draining the Airport property were monitored more frequently to assess the impacts of construction on surface water resources. Specifically, this consisted of sampling Wrights Creek above Andrews Pond on a regular biweekly basis. Event samples were also collected immediately during and after major rain events. During this phase of the program, groundwater quality was monitored at test wells 8,9,10 and 11 and at the three municipal pumping stations.

5.2 Presentation of Water Quality Results

A number of sampling sites were incorporated into the water resource assessment program to first characterize and then monitor the ground and surface waters in the vicinity of the Airport. Specifically, samples were obtained from 11 wells on or adjacent to the existing Airport property, 5 wells adjacent to the proposed runway, three municipal pumping stations (Malpeque, Union and Brackley) and five surface water stations (Wrights Creek above Andrews Pond, Andrews Pond at Highway 2, Andrews Pond at Spillway, Winter River South Branch at Union Road, and Malpeque Stream at Highway 2)(Figure 9). The parameters measured for both surface and groundwater samples are summarized in Table 7.

The sampling methodology used to collect surface and groundwater samples is presented in Appendix 1. Raw water quality determinations for the various sampling stations and statistical summaries by parameter are found in Appendices 2 and 3, respectively.

The major ion data consisting of cations (calcium, magnesium, sodium and potassium) and anions (carbonate, sulfate and chloride) are presented in Figure 16. Trilinear diagrams provide a convenient method to illustrate chemical differences and similarities between waters. The anions and cations shown in Figure 16 were first converted to meq/l and then plotted in the trilinear diagram.

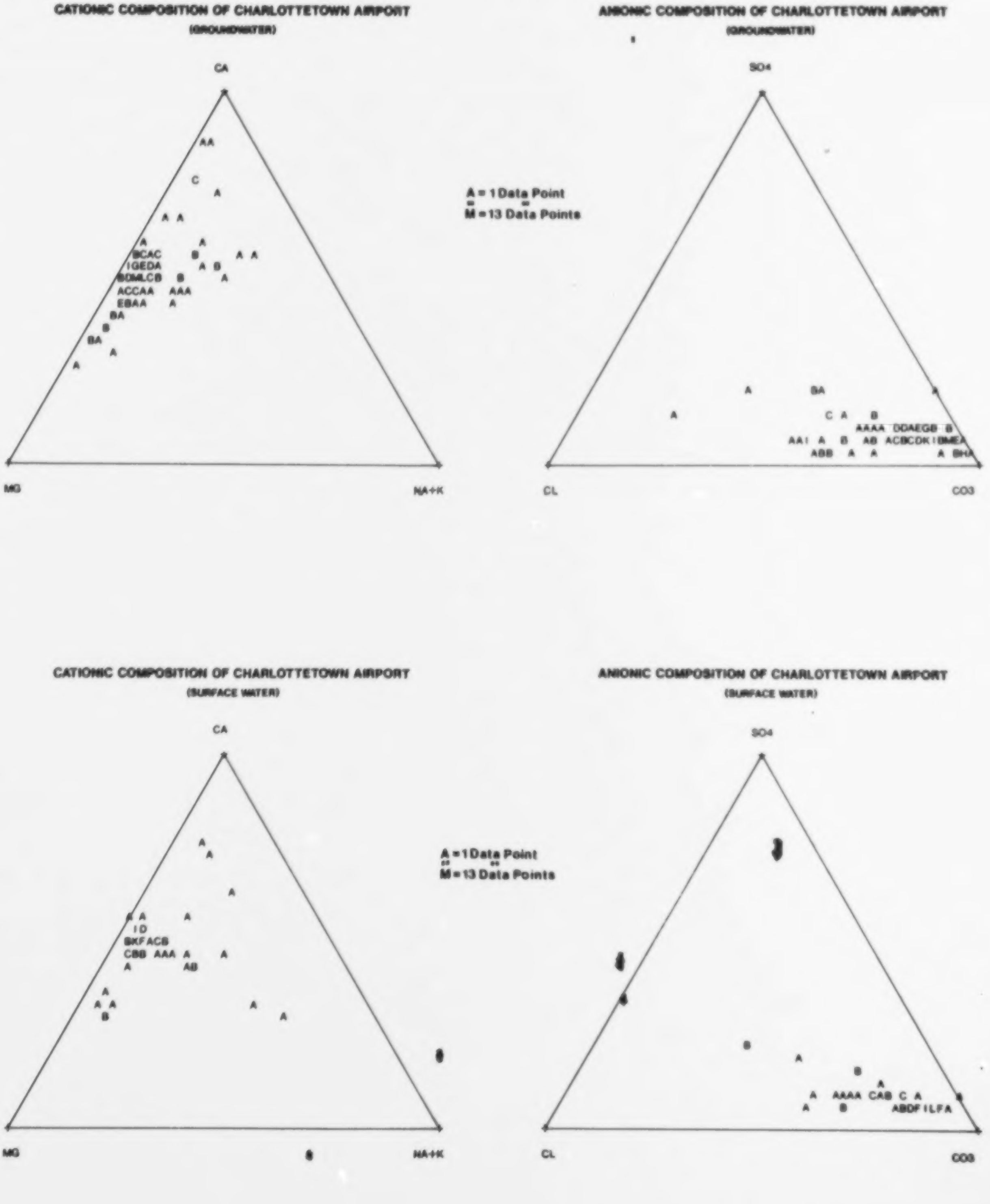
Surface and groundwater chemistry presenting means and ranges along with the Canadian Drinking Water Standards and Objectives(12) and Guidelines for Livestock and Wildlife Watering(7) is presented in Table 8. The historical water quality data established by Dyck(13) of the

Table 7

PARAMETERS MEASURED

Parameter	Groundwater	Surface Water
Field		
Temperature	X	X
Specific Conductance	X	X
pH	X	X
DO		X
Turbidity	X	X
Depth of Water Table	X	
Well Pumped or not	X	
Laboratory		
Temperature	X	X
pH	X	X
Specific Conductance	X	X
Turbidity	X	X
Color	X	X
Calcium	X	X
Magnesium	X	X
Potassium	X	X
Sodium	X	X
Alkalinity	X	X
Chloride	X	X
Sulphate	X	X
Phosphorus	X	X
Silica	X	X
Manganese	X	X
Iron	X	X
Copper	X	X
Lead	X	X
Zinc	X	X
Total Organic Carbon	X	X
Total Inorganic Carbon	X	X
Nitrate + Nitrite	X	X
Ammonia	X	X
Nitrogen Total	X	X
Phenols	X	
Urea	X	X
Hydrocarbons - Kerosene	X	
Hydrocarbons - Jet Fuel	X	
Hydrocarbons - Diesel Fuel	X	
Hydrograbons - Stove Oil	X	
Hydrocarbons - Furnace Oil	X	
Hydrocarbons - Bunker Oil	X	
Hydrocarbons - Gasoline	X	

IONIC COMPOSITION OF SURFACE WATER AND GROUNDWATER AT CHARLOTTETOWN AIRPORT


CATIONIC COMPOSITION OF CHARLOTTETOWN AIRPORT (GROUNDWATER)

ANIONIC COMPOSITION OF CHARLOTTETOWN AIRPORT (GROUNDWATER)

CATIONIC COMPOSITION OF CHARLOTTETOWN AIRPORT (SURFACE WATER)

ANIONIC COMPOSITION OF CHARLOTTETOWN AIRPORT (SURFACE WATER)

FIGURE 16

Table 8

COMPARISON OF THE SURFACE AND GROUNDWATER CHEMISTRY TO THE

CANADIAN DRINKING WATER STANDARDS AND OBJECTIVES

AND LIVESTOCK AND WILDLIFE CRITERIA

Parameters*				Surface Water			Groundwater		
	Objective	Acceptable	Livestock & Wildlife Watering Criteria	Max.	Min.	Av.	Max.	Min.	Av.
Temperature (^{o}C)	15^{o}C	<15^{o}C	-	18.5	1.0	8.1	9.5	2.0	7.3
pH	-	-	-	8.6	6.6	-	9.0	6.0	-
Spec. Conductance USIE/cm	-	-	-	402.0	75.2	306.1	788.0	76.0	341.0
Turbidity (JTC)	<1.0	<5.0	-	110.0	0.1	7.0	83.0	<0.5	23.3
Colour App. (TCU)	<15.0	<15.0	-	100.0	<5.0	18.3	>100.0	<5.0	9.3
Alkalinity Total	-	30 - 500	-	168.0	10.0	112.5	255.0	9.2	125.7
Calcium	<75.0	<200.0	<1000.0	42.0	4.1	29.3	70.0	6.0	32.9
Magnesium	<50.0	<150.0	-	35.0	2.0	15.7	50.0	3.0	16.6
Potassium	-	-	-	6.0	1.1	1.9	11.0	0.6	2.5
Sodium	-	<270.0	-	16.0	1.7	6.8	32.0	2.8	7.8
Chloride	<250.0	<250.0	-	29.0	0.7	14.0	92.0	0.9	22.0
Sulfate	<150.0	<500.0	<1000.0	14.0	4.8	10.4	36.2	4.1	11.8
Phosphorus Total	0.065**	<0.2	-	0.47	0.02	0.10	1.2	0.01	0.16
Silica (Reactive)	-	-	-	7.0	0.9	4.8	9.0	<0.1	5.4
Fluoride	<1.0	<1.5	<2.0	0.08	<0.05	<0.05	1.7	<0.05	0.2
Carbon (Tot. Org.)	-	-	-	24.8	<0.5	7.3	54.4	<0.5	6.6
Carbon (Tot. Inorg.)	-	-	-	44.0	5.7	27.5	64.3	6.8	31.6
Nitrogen (Dis-NH_4)	<0.01	<0.5	-	1.35	<0.005	0.07	7.32	<0.005	0.28
Nitrogen (Total)	-	-	-	8.3	0.34	3.55	12.0	0.03	2.44
Nitrogen (NO_2 + NO_3)	<0.001	<10.0	<20.0	6.4	0.15	3.38	11.0	<0.005	2.16
Copper	<1.0	<1.0	<0.5	0.009	<0.002	<0.002	0.037	<0.002	<0.009
Lead	<0.001	<0.05	<0.05	0.003	<0.002	<0.002	0.004	<0.002	<0.002
Zinc	<5.0	<5.0	<25.0	0.011	<0.002	<0.002	0.036	<0.002	0.009
Manganese	<0.01	<0.05	-	0.21	<0.01	0.02	9.2	<0.01	0.38
Iron	<0.05	<0.3	-	0.70	0.006	0.101	2.0	0.015	0.405
Cadmium	<0.001	<0.005	<0.01	<0.001	<0.001	<0.001	-	-	-
Arsenic	<0.005	<0.05	<0.05	<0.005	<0.005	<0.005	-	-	-
Urea	-	-	-	1.6	<0.01	0.16	0.36	<0.01	0.05
Phenols	<0.002	<0.002	-	-	-	-	0.017	<0.002	<0.002
Gasoline	-	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

* Unless otherwise indicated, all units are in mg/l

** Total Inorganic

Table 9

Historical Water Quality Data

Parameter	Dyck's Work	P.E.I. DOE Well Quality (1975)	P.E.I. DOE Spring Quality (1975)
Calcium	20.0	31.8	22.2
Magnesium	-	16.1	11.4
Sodium	-	7.0	6.2
Potassium	1.0	1.99	1.53
Sulfate	10.0	10.2	10.9
Chloride	10.0	14.6	16.7
Nitrate	2.9 - 3.3	14.5	8.9
Bicarbonate	-	137.3	88.2
Phosphate	-	0.10	0.11
Organic Carbon	-	-	-
Inorganic Carbon	-	-	-
Iron	0.1	0.0	0.1
Manganese	0.0	0.02	0.02
Alkalinity	100.0	-	-
Hardness	-	163.6	137.0
Conductivity (uMHO/cm)	200.0	318.0	271.0
TDS	-	253.0	202.0
pH (Units)	7.0 - 7.9	7.8	7.3
Colour (App) TCU	-	-	-
Turbidity (JTU)	-	-	-
Lead	-	<0.1	<0.1
Zinc	-	0.07	0.06
Copper	-	<0.02	0.03
Ammonia	-	<0.2	<0.2
Temperature (°C)	-	11.5	8.7
Silicon (reactive)	-	-	-
Total Nitrogen	-	-	-
Fluoride	-	-	-

Note: Spring data unreliable; one spring was surface bog water.

All values are in mg/l unless otherwise stated.

Geological Survey of Canada and the Prince Edward Island Department of Community Affairs/Environment Division(9) are presented on Table 9.

5.3 Discussion of Water Quality Results

As previously mentioned, a number of water quality parameters were determined on the surface and groundwater samples collected as part of the water resource evaluation program (Table 7). These parameters can be, as discussed below, divided into the following 2 general parameter types: natural (major ion, physical parameters, iron, manganese) and anthropogenic (nitrogen, urea, phenols, petroleum hydrocarbons, and turbidity).

5.3.1 Natural Influences on Water Quality

Referring to the point density trilinear diagrams (Figure 16) it is apparent that the major ion chemistry for surface and groundwater in the vicinity of the Airport are similar. The water can be classified according to Hem, 1959, as being calcium-magnesium-bicarbonate rich water(14). The scatter of the cationic and anionic data is primarily due to increased concentrations of sodium and chloride, respectively. Examination of the water quality data presented in Appendix 2 reveals that the highest concentrations of sodium and chloride were obtained in wells 5 and 8 and at the Andrews Pond dam. The high levels of sodium and chloride at these locations may reflect road salting activities within their respective watersheds.

In addition to the major ion chemistry data presented in the trilinear diagrams, overall mean anionic and cationic water quality is summarized below in Table 10.

Table 10

SUMMARY OF MEAN ANIONIC AND CATIONIC DATA
FOR SURFACE WATER AND GROUNDWATER

	Groundwater		Surface Water	
	mg/l	meq/l	mg/l	meq/l
Ca	32.9	1.64	29.3	1.47
Mg	16.6	1.37	15.7	1.29
Na	7.8	.34	6.8	.30
K	2.5	.06	1.9	.05
SO_4	11.8	.25	10.4	.22
Cl	22.	.62	14.	.39
Alk.	125.7	2.51	112.5	2.25

The similarities in anionic and cationic compositions for both surface and groundwaters presented in the trilinear diagrams as well as the data in Table 10 suggest that base flow contributions to the streams draining the Airport is the dominant factor governing major ion chemistry. The high baseflow contributions to streams on Prince Edward Island was confirmed by a baseflow separation study for the Winter River Basin conducted by the Inland Waters Directorate(5).

It is apparent that the Airport surface and groundwater quality results are comparable to the previously established historical data. In addition, it is recognized that the water quality data, with minor exceptions and excluding certain parameters such as iron, manganese, colour, turbidity, and ammonia, are well within the accceptable drinking water standards.

Iron levels within the wells ranged from 0.015 to 2.0 mg/l, whereas manganese ranged from <0.01 to 9.2 mg/l. The mean iron and manganese levels in groundwater were 0.41 and 0.38 mg/l, respectively. High iron and manganese levels are known to exist as a problem in Prince Edward Island wells, but the typical levels throughout the Island groundwaters are not as high as those reported in the Airport wells. The high levels of iron and manganese found in these wells may relate to the high suspended particulate and turbidity levels observed in the wells following pumping activity. Suspended sediments would tend to increase the ferric iron and manganic manganese levels in the samples. In addition, the well casing itself was made of iron, which may increase iron concentrations through leaching and dissolution processes. These reasons may explain the anomalous iron and magnesium results observed on the Airport property by comparison to the remaining Island wells. Comparisons between mean and, for that matter, median iron and manganese levels in the Airport wells to the Canadian Drinking Water Standards(12) reveal that the levels of iron and manganese are excessive.

The specific conductance levels for all water samples obtained ranged from 75 to 788 USIE/cm. The high variability of conductivity in the water may be, in part, the result of sediments which would tend to liberate and thereby contribute to the high levels of TDS and hence, conductivity measured in the water samples. To illustrate the phenomenon, Dyck measured and observed that the conductivity levels in well water samples containing sediment were approximately 25% higher than levels obtained from the same water without sediment.(13) Elevated groundwater conductivity values are normally associated with the dissolution of matrix material from within the aquifer itself. Mean conductivity levels for both ground and surface waters are 341 USIE/cm and 306 USIE/cm respectively. Elevated surface water conductivity values primarily result from high baseflow contributions.

The pH of surface and groundwaters was generally above 7.0 units with a median of 7.90, suggesting that all waters within and adjacent to the Airport are moderately well buffered and alkaline.

5.3.2 Anthropogenic Influences on Water Quality

Anthropogenic water quality parameters including ammonia, nitrite and nitrate, urea, phenols, kerosene and gasoline were of utmost importance to the water resources assessment program. In order to assess the degree to which construction activities were influencing receiving waters within the vicintiy of the airport, a series of special rain event samples were collected from Wrights Creek and monitored for turbidity. These data enabled assessment of the effects that the existing and proposed facility are currently having and will continue to have on water resources. Phenolic materials are derived from hydroxyl derivatives of benzene and its condensed nuclei(15, 16). The usual sources of phenolic materials include industrial waste water, hydrocarbons, aircraft maintenance operations, degradation products of various pesticides and herbicides and natural occurring substances.(17) Urea is found to occur in animal and human wastes and in various fertilizers containing nitrogen based compounds. In addition, it is extensively used as a deicing agent on Airport runways. The major sources of hydrocarbons include automotive and aviation fuels while minor amounts of hydrocarbons are produced in certain environments through microbial degradation processes.(15,16)

All of the aforementioned anthropogenic parameters were determined in the groundwater sampling sites whereas only petroleum hydrocarbons and urea were determined in surface waters.

The wells on the Airport property consistently showed that nitrite + nitrate and urea measurements were higher than levels obtained from the adjacent private property wells. Throughout the duration of the study, intensive agricultural activities within the vicinity of private wells (A-E) were not practiced suggesting that nitrite + nitrate levels measured in this area are reflective of natural influences on groundwater quality. Conversely, the nitrite + nitrate levels obtained from the Airport wells may reflect cultural influences on water quality resulting from septic tank contributions and/or urea applications.

In 1979, Airport well number 9 was drilled adjacent to well number 1 to monitor the influence of runway urea applications on groundwater quality. Well number 9 contained the highest levels of nitrite and nitrate and urea measured in Airport wells. Nitrite + nitrate and urea levels (as N) in this well ranged up to 11.0 mg/l to 0.14 mg/l, respectively. It is suggested that urea which is applied to the adjacent runway could be converted by microbial oxidation processes (nitrification) to nitrite and finally to nitrate. Consequently, urea levels would be reduced whereas nitrogen concentrations (i.e. nitrate) would be increased in groundwater. In fact, it has been reported that the transformation of urea, which is 46% nitrogen, into ammonia and ultimately into nitrate, occurs within 10 days(17).

The presence of urea and, in particular, nitrate in the groundwater within the Airport wells indicates urea applications can infiltrate groundwater aquifers. Care must be taken in the future to minimize the buildup of nitrate concentrations in the aquifers. There are a number of cases which suggest that nitrate contamination of groundwater supplies can occur from urea (fertilizer) applications. For example, an application rate of 169.2 kg/ha/year of urea resulted in contamination of groundwater to the extent of 11 mg/l (as N)(17). Prior to applying the fertilizer, the background concentration of NO_3^- in the groundwater was less than 2.4 mg/l (as N). The Ministry of Transport has spread up to 27.6 metric tons of urea per year on the existing runway (2134 M long). Assuming that the urea and its breakdown products are spread over a 25 M band on either side of the runway, the loading rate would be 2590 kg/ha/year. As such, applications of this magnitude may jeopardize groundwater resources in the area if special care is not taken to prevent urea from infiltrating groundwater aquifers.

The mean ammonia, and nitrite + nitrate levels were compared to the acceptable ranges of the Canadian Drinking Standards. In terms of surface water quality, the mean nitrite and nitrate levels were within the acceptable range of the Drinking Water Standards. Similarly, the mean ammonia levels for surface waters conformed with the drinking water standards.

However, on one occasion ammonia levels in surface waters exceeded the drinking water standards by .85 mg/1. Because this was 1 to 2 orders of magnitude higher than all other samples obtained from that site, this value probably reflects analytical problems, sample contamination, or both. In terms of groundwater, mean ammonia and nitrite + nitrate levels were below the acceptable concentration. However, ammonia levels observed at Well 4 exceeded acceptable drinking water standards on one occasion. Ammonia levels at Well 5 exceeded acceptable drinking water standards on six of nine occasions. In fact, ammonia levels up to 7.3 mg/1 (as N) were observed at this location. The source may be a nearby abandoned septic system. Nitrite + Nitrate levels in groundwater exceeded drinking water standards at Well 9 on the only occasion it was sampled under the program (11 mg/1 as N). However, an additional sample acquired by the Prince Edward Island Department of Community Affairs had nitrite + nitrate levels of 14 mg/1 (as N). In view of the elevated levels of nitrite + nitrate at additional wells, and considering groundwater flow patterns as previously established, it is felt that groundwater contamination results primarily from the application of urea on airport surfaces, and secondarily from snow piles, laden with urea and stored upgradient from wells numbered 1, 9 and 10.

Kerosene and gasoline were consistently below the analytical detection limit and were therefore within the objective range of the Canadian Drinking Water Standards. Soil analysis on 3 randomly drilled tests pits situated in the vicinity of the present fire training area, revealed that hydrocarbons were not present to a depth of 4.6 metres.

The mean value of phenolic materials within all wells was close to the analytical detection limit and the drinking water standard (0.002 mg/1). Phenols in individual samples ranged from <0.002 to 0.017 mg/1. Of the Airport wells, the highest phenol levels were observed in wells 3 and 5. The phenolic levels found in well 5 may result from either fire training operations and/or from waste introduced by the septic tank system located near well 4, or from aircraft maintenance. Aircraft maintenance practices have been reported to contribute phenolic substances to wastewater, ranging from 200 to 400 mg/1.(16) The source of phenols from aircraft maintenance may relate to the cleaners used for the planes. It is known, for example, that plane cleaners in common use at the Halifax International Airport contain approximately 35 mg/l of phenol. The phenolic substances discovered in wells D and E is difficult to explain, but may result from natural occurring substances. However, additional assessment would be required to determine the source(s) of phenol in these particular wells.

As previously mentioned, a number of special rain event samples were obtained from Wrights Creek above Andrews Pond to assess erosion/sedimentation phenomena concurrent with construction activities. The most appropriate indicator parameter which can be used to assess the impacts resulting from erosion is turbidity. Turbidity levels within Wrights Creek were highly variable and ranged from 0.1 to 110 J.T.U. Referring to Appendix 2, it becomes apparent that turbidity levels are highest during spring and fall months, particularily during the last year of the study when heavy rains would tend to erode uncovered soil material and transport it to receiving waters. It is difficult to quantify the impact of construction activities within the Airport property because of the presence of downstream urban activities.

6. CONCLUSIONS AND RECOMMENDATIONS

Based on the results of this study and through discussions with officials of the Prince Edward Island Department of Community Affairs/-Environment Division, the Ministry of Transport and the Environmental Protection Service , Environment Canada, regarding the design of the Charlottetown Airport redevelopment project, the following conclusions and recommendations were drawn:

Hydraulic gradients of the water table aquifer(s) were determined on the basis of several groundwater level surveys. Based on an analysis of groundwater flow patterns, contaminants associated with the proposed runway would move down the groundwater flow system towards the Winter River. Contaminants associated with the remaining components of the proposed airport redevelopment (e.g. fire training area, aprons/ taxiways, terminal building, combined services facility, etc.) will move down the groundwater flow system towards either Wright's Creek, Winter River, or both.

The results of the water quality assessment suggest that the general water quality parameters (major ions, pH, alkalinity) are comparable to prevailing water quality conditions throughout Prince Edward Island. The chemical characteristics of surface and groundwater within the study area were similar, suggesting that base flow is the major factor controlling surface water quality. Both surface and subsurface waters are moderately hard, alkaline and classified as calcium-magnesium-bicarbonate types.

The anthropogenic water quality parameters examined included gasoline, kerosene, ammonia, nitrate and nitrite, urea, phenols and turbidity. Gasoline and kerosene were consistently below analytical detection and therefore were within the objective range of drinking standards. However, phenol levels were reported at a number of stations and, on a number of occasions, mean phenol levels were above acceptable drinking water standards. High phenolic levels were observed in wells adjacent to the existing fire training area and are considered to result from either fire training activities or from the septic tile field nearby. High phenols were also determined in the test wells situated on private property. An explanation of this phenomena is difficult to offer at this time. High urea levels, particularly those measured within wells no. 9 and 10, may have resulted from the application of urea to the runway and tarmac during winter months.

High levels of nitrite + nitrate were observed at well No. 9 (11 mg/l as N), located some 120m downgradient from the runway, and at well No. 10 (8 mg/l as N) located some 425m downgradient from the runway. The P.E.I. Department of Community Affairs obtained a further sample from well No. 9 on November 23, 1981. The level of NO_2 + NO_3 was 14 mg/l (as N), further substantiating the data base. In view of the domestic wells located downgradient of the existing runway and to improve predictive capability regarding the proposed runway, WE RECOMMEND:

(1) THAT A SIX-INCH TEST WELL BE ESTABLISHED BETWEEN TEST WELLS #9 AND #10 AT OR NEAR THE AIRPORT PROPERTY BOUNDARY.

It must be emphasized that a number of potential short and long- term water resource impacts could result from both the construction and operational phases of the redevelopment project. Impacts to groundwater resources, particularly the well fields within the Winter River Basin which supply water to the City of Charlottetown, could result from application of de-icing agents on the runway. Furthermore, contaminants associated with such Airport facilities as the apron, taxiways, terminal building, public and employee parking lot, fire training area, etc. could flow into Wrights Creek either directly through the surface and underground drainage systems or indirectly via the groundwater flow system: factors which could potentially impair ground and surface water quality within the Wrights Creek watershed. In the vicinity of the combined services building and solar energy facility, the groundwater divide between Wrights Creek and Winter River Basin is coincident with the proposed locations of the above buildings suggesting that contaminants could flow into either watershed.

Accordingly, WE RECOMMEND:

(2) THAT THE MINISTRY OF TRANSPORT, IN CONJUNCTION WITH THE APPROPRIATE FEDERAL AND PROVINCIAL REGULATORY AGENCIES, CONTINUE THE WATER QUALITY MONITORING PROGRAMME IN ACCORDANCE WITH THE PREVIOUSLY DEFINED WATER QUALITY PARAMETERS.

(3) THAT WATER SAMPLES BE COLLECTED FROM TEST WELLS 8, 9, 10 AND 11, THE THREE MUNICIPAL PUMPING STATIONS AND ALL MAJOR STREAMS DRAINING THE AIRPORT PROPERTY, ON A QUARTERLY BASIS.

(4) THAT THE MONITORING PROGRAM BE SUPPLEMENTED WITH ADDITIONAL SAMPLES OBTAINED FROM THE NEW WELL, THE QUARRY (NORWOOD ROAD) LOCATED DOWNGRADIENT FROM THE AIRPORT, PRIVATE DOMESTIC WELLS IN THE AREA AND ANY SPRINGS WHICH MAY BE FOUND IN THE AREA.

The monitoring program should be implemented throughout the construction and initial operating phases of the project to detect changes, if any, in water quality. The monitoring program would provide early indications of the degree to which local ground and surface water resources are influenced by construction and operational activities.

While it can be concluded that the use of urea as a de-icing agent will dramatically affect the levels of NO_2 + NO_3 in local groundwater aquifers, it is difficult at this time to determine if local domestic wells or the municipal well fields will be affected. Accordingly, WE RECOMMEND:

(5) THAT THE CONSULTANT, TO BE ENGAGED BY MOT TO PREPARE A CONTINGENCY PLAN FOR POLLUTION ABATEMENT, (1) REASSESS THE EXISTING DATA BASE IN VIEW OF THE ADDITIONAL DATA ACQUIRED SINCE COMPLETION OF THIS STUDY; (2) DETERMINE THE NEED FOR AND POSSIBLE CONFIGURATION OF A GROUNDWATER QUALITY MONITORING NETWORK NECESSARY TO PROVIDE AN EARLY WARNING OF GROUNDWATER CONTAMINATION; AND (3) CONSIDER VARIOUS MITIGATING MEASURES TO ALLEVIATE WATER POLLUTION PROBLEMS. THESE MEASURES MAY INCLUDE, BUT ARE NOT LIMITED TO, USE OF NITROGEN FIXING VEGETATION, THE DISPOSAL OF SNOW AND ICE IN LESS SENSITIVE AREAS AND THE ALTERNATE USE OF THE EXISTING RUNWAY WHEN UREA APPLICATIONS ARE REQUIRED IN LARGE QUANTITIES.

(6) THAT ALTERNATIVE STRATEGIES BE IMPLEMENTED TO MINIMIZE IMPAIRMENT OF DOMESTIC AND MUNICIPAL WATER SUPPLIES LOCATED DOWN-GRADIENT OF THE AIRPORT, SHOULD WATER RESOURCES IN CLOSE PROXIMITY TO THE AIRPORT BECOME CONTAMINATED.

The majority of the Airport redevelopment project will take place on the Charlottetown soil series which are, in turn, underlain by sand-rich surficial deposits. These soils exhibit relatively high permeabilities and contain small quantities of fine-grained silt and clay-sized fractions. The attenuative capacity of the soil, and hence the ability to adsorb contaminants, relates to the amount of fine grained materials present which have large surface area/volume ratios. The high permeability of the Charlottetown soils combined with the lack of fine-grained materials suggest that these soils may not afford adequate protection to groundwater resources from various Airport activities such as urea applications. Therefore, contaminants such as urea, glycol, hydrocarbons and additional pollutants may migrate with relative ease through the Charlottetown soils into local aquifers.

The problem of contaminant migration and consequent impairment to local aquifers may be magnified during the construction and operational phases of the project since the soil cover will be excavated, thereby exposing the mineralized sand-rich surficial deposits. With the exception of the parking lot area, the majority of construction will be confined to the sand-rich and glacio-fluvial deposits. Therefore, it is imperative that extreme caution be exercised during the construction and operational phases of the facility to ensure that contaminants are retained to minimize impairment of the aquifers.

To minimize potential damage to surface water bodies and groundwater aquifers from hazardous materials, WE RECOMMEND:

(7) THAT A CONTINGENCY PLAN BE DEVELOPED TO ENSURE THE EXPEDIENT CLEAN-UP OF FUEL SPILLAGE FROM HEAVY CONSTRUCTION EQUIPMENT.

(8) THAT CONSTRUCTION CREWS BE INFORMED OF (a) THE SENSITIVE NATURE OF THE AREA, AND (b) THE IMPORTANCE OF ENVIRONMENTALLY SOUND WORK HABITS.

(9) THAT PEAT OR SAWDUST OR OTHER SUITABLE ABSORBANTS BE STORED ON SITE THROUGHOUT THE CONSTRUCTION PERIOD, AND THAT CONSTRUCTION CREWS BE EDUCATED IN THE USE OF ABSORBANT MATERIALS AND THE METHODS USED TO REMOVE CONTAMINATED SOILS DURING FUEL SPILL CLEAN-UP OPERATIONS

(10) THAT CONSTRUCTION ACTIVITIES BE ROUTINELY MONITORED TO ENSURE THE ADHERENCE OF THESE RECOMMENDATIONS THROUGHOUT THE ENTIRE CONSTRUCTION PERIOD.

The most obvious visual impact associated with construction activities is increased soil erosion and the subsequent siltation of adjacent receiving waters. This study did not quantitatively assess the relationship between airport construction activities and stream water quality. Detailed evaluation of potential water quality impacts would require the collection of baseline data from various locations along streams in the airport area. However, during the spring and fall of 1979, high turbidity levels were observed in streams draining airport property. Stream siltation from land erosion is aggravated by heavy rains and may in part result from Airport redevelopment work.

WE THEREFORE RECOMMEND:

(11) THAT THE TOTAL AREA UNDER CONSTRUCTION AT ANY GIVEN TIME BE MINIMIZED.

(12) THAT THE DURATION OF CONSTRUCTION ACTIVITY BE MINIMIZED.

(13) THAT CONSTRUCTION ACTIVITIES INVOLVING CONSIDERABLE TERRAIN DISTRUBANCES BE IMPLEMENTED DURING THE SUMMER (i.e. LOW FLOW) MONTHS.

(14) THAT BUFFER ZONES (GREEN BELTS) BE ESTABLISHED AND MAINTAINED ADJACENT TO WATERCOURSES.

(15) THAT ON-SITE STABILIZATION TECHNIQUES BE ROUTINELY PRACTICED DURING THE CONSTRUCTION PHASE BY ENSURING THAT MULCH, POLYETHYLENE SHEETING AND/OR SUITABLE MATERIALS BE PLACED OVER EXPOSED AREAS TO MINIMIZE EROSION AND SILTATION FOR THE SHORT TERM.

(16) THAT, IF CONSTRUCTION SITE STABILIZATION EFFORTS ARE NOT EFFECTIVE, CONSIDERATION BE GIVEN TO INSTALLING AND MAINTAINING EROSION CONTROL DEVICES, SUCH AS SILTATION BOXES AND SETTLING PONDS, IN STREAMS AFFECTED BY AIRPORT CONSTRUCTION ACTIVITIES.

(17) THAT IMMEDIATELY FOLLOWING CONSTRUCTION, EXPOSED AREAS BE SEEDED/SODDED TO PROVIDE LONG TERM EROSION CONTROL AND SITE STABILIZATION.

(18) THAT IF STREAM BANK STABILITY IS ADVERSELY AFFECTED BY INCREASED SURFACE RUNOFF, OR IF OTHER SPECIFIC EROSIONAL PROBLEMS DEVELOP, CONSIDERATION SHOULD BE GIVEN TO ESTABLISHING EROSION CONTROL DEVICES SUCH AS RIP-RAP, GABION BASKETS OR OTHER SUITABLE STRUCTURES.

The tentative design of the fire training area involves levelling an area, surrounding it with clay berms and underlaying the entire site with a clay liner. However, the degree to which this type of design will afford protection to the local ground and surface water resources is not currently known. The hydraulic gradients within the vicinity of the fire training area would favour the movement of groundwater towards the Wrights Creek Basin in which domestic groundwater supplies are located. Furthermore, surface water drainage from the site will be directed into Wrights Creek. Accordingly, WE STRONGLY RECOMMEND:

(19) THAT THE MINISTRY OF TRANSPORT INVESTIGATE THE FEASIBILITY OF INSTALLING AND MAINTAINING AN IMPERVIOUS LINER WITHIN THE FIRE TRAINING AREA.

(20) THAT SURFACE RUNOFF GENERATED FROM WITHIN THE FIREFIGHTING AREA BE COLLECTED AND TREATED PRIOR TO DISCHARGE INTO THE WRIGHTS CREEK WATERSHED.

Discussions with the Ministry of Transport have revealed that consideration has not as yet been given to pollution abatement strategies for fuel and/or glycol spills as well as for normal storm and runway drainage systems. There remain a number of potential receiving surface and/or groundwater concerns which could result from fuel spills and/or the proposed runway drainage system. Should fuel spills occur along the proposed runway, groundwater flow patterns are such that the fuel would be transported into the Winter River Basin towards the municipal well fields.

Accordingly, WE RECOMMEND:

(21) THAT THE MINISTRY OF TRANSPORT DEVELOP AND IMPLEMENT A DETAILED AND COMPREHENSIVE POLLUTION ABATEMENT STRATEGY TO DEAL WITH ACCIDENTAL FUEL AND/OR GLYCOL SPILLS.

The placement of fuel storage tanks below the ground surface is a potential source of contamination to the groundwater resources of the area and, as such, represents a significant water resources concern. Recent discussions with the Ministry of Transport have revealed that underground oil storage tanks have been installed within the new Combined Services Building. In the event of tank rupture, extensive contamination of groundwater resources and water supplies could occur. Hydraulic gradients within the vicinity of the Combined Services Building could favour the movement of contaminants within the groundwater flow system either to the Winter River Basin, in which two well fields are located, or into the Wrights Creek Basin, in which domestic groundwater supplies are located. Should these aquifers become contaminated by underground fuel storage tank rupture(s), the Ministry of Transport could be responsible for developing alternative sources of water supply for those areas affected. In fact, two gasoline leaks from underground storage tanks recently occurred in Kensington, Prince County, Prince Edward Island and resulted in contaminating approximately 31 domestic groundwater supplies. The petroleum plume was estimated to cover an area of approximately 45 hectares. It was demonstrated that approximately 11,365 liters leaked from the tanks with a very high percentage actually reaching and travelling within the upper water table aquifer. A monetary settlement was provided to the Town of Kensington by the companies responsible for the problem to pay for ameliorating measures with the possibility of future monetary settlements should additional wells become affected.

In order to prevent potential contamination of domestic and/or municipal groundwater supplies, **WE RECOMMEND:**

(22) THAT OVERGROUND, RATHER THAN UNDERGROUND OIL STORAGE FACILITIES BE USED.

(23) THAT THE UNDERGROUND FUEL STORAGE FACILITY WHICH WAS INSTALLED FOR THE COMBINED SERVICES BUILDING BE REMOVED AND REPLACED WITH AN ABOVE-GROUND FACILITY.

(24) THAT OVERGROUND FUEL STORAGE BE ESTABLISHED ON A CONCRETE PAD AND ENCLOSED WITH AN IMPERVIOUS BERM DESIGNED TO RETAIN 1.2 TIMES THE VOLUME OF TOTAL STORAGE CAPACITY.

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APPENDIX I

Sampling Methodologies

(Surface and Groundwater)

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Introduction

In support of the water resources evaluation program a number of surface and groundwater samples were collected. The sample collection techniques used to obtain surface and groundwater quality samples are discussed below separately

A. Surface Water Sample Collection Techniques

All surface water samples which were obtained from the streams draining the airport were collected by hand. Particular care was taken to ensure that the sample would not be contaminated by sediment, debris and/or other floating substances. All sampling bottles excluding those used for urea determinations were partially filled and rinsed with stream water. The sampling bottles were then refilled with stream water, preserved (where appropriate) and labelled. Information concerning surface water sampling methodologies and preservation techniques can be obtained from the Water Quality Branch of the Inland Waters Directorate in Moncton, New Brunwick.

Field determinations were conducted either in the field vehicle or at the Water Resources Branch sub-office in Charlottetown immediately following collection. Information concerning the field methodologies and analytical techniques can be obtained from the Water Quality Branch in Moncton.

B. Groundwater Sample Collection Techniques

The sampling procedure used for the collection of groundwaters involved pumping, if and when possible, each well prior to obtaining the water sample. For those wells pumped, a submersible pump was lowered into the well until it rested on the bottom or as near to the bottom as possible and the well was pumped either for a period of within 10-15 minutes or until the well ran dry. Once the well was pumped dry it was permitted to refill and re-pumped dry again. This procedure was repeated at least twice or until the water was no longer turbid to ensure that detritus material present in the well water would be removed.

Groundwater samples were collected in a kemmerer stainless steel water sampler. The following steps outline the methods used to obtain the groundwater samples.

(1) If the depth of the well was not known, it was determined by lowering a weighted line until it rested on the bottom. This was

done carefully to reduce sediment re-suspension from the bottom of the well. The sample was then collected after approximately 10-15 minutes to ensure that suspended particulate matter would settle to the bottom of the well.

(2) The open water sampler was carefully lowered into the well avoiding contact with the walls in order to prevent/minimize sample contamination. When the water sampler was approximately 1 metre above the bottom of the well, the sampler was closed by releasing the messanger. This process was repeated until a sufficient volume of water was collected.

(3) When filling the sample bottles, extreme caution was exercised to avoid contaminating the well samples. A tygon hose was attached to the drain valve at the bottom of the sampler to deliver the water into the sample bottles. Before depressing the drain valve, the sampler was held upright and the top loosened to allow air to enter the sampler while the drain valve was depressed. The tygon hose was removed each time the sampler was lowered into the well for another sample.

(4) Once the sample was collected, it was preserved in the field. The various field parameters were measured immediately after collecting the sample.

(5) When collecting water samples for phenols and/or hydrocarbons, the sample was collected from the air-water interface.

From March 1979 to the end of the study, all wells were pumped prior to collecting the water sample. The samples were obtained from a PVC pump hose after the sample bottles were rinsed. Aside from the above, the sampling techniques and preservation procedures remained the same. Once the samples were obtained, field measurements were immediately performed in the vehicle. Specific information concerning groundwater sampling methodologies and preservation techniques can be obtained from the Water Quality Branch of the Inland Waters Directorate in Moncton, New Brunswick.

APPENDIX II

Raw Water Quality Data

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Andrews Pond at Hwy 2 Culvert
NAQUADAT STN. NO. 01PE01CC0001

Field Parameters	Oct 13/76	Nov 30/76	Feb 9/77
Temp. Water (Deg. °C)			
Spec. Conductance (USIE/cm)			
pH (pH Units)	8.1	7.5	8.1
Hach D.O. (mg/l)			
Turbidity (JTU)			
Depth of Water Table (m)			
Well pumped			
Lab Parameters			
Temp. Water (Lab) Deg. °C	25.	25.	25.
pH (pH units)	8.1	7.5	8.1
Spec. Conduct. (USIE/cm)	300.	176.	340.
Turbidity (JTU)	19.	34.	
Colour Apparent (Rel. units)	25.	30.	L5.0
Calcium Dissolved (mg/l)	34.0	14.5	37.0
Magnesium Dissolved (mg/l)	17.5	7.0	18.2
Potassium Dissolved (mg/l)	2.1	4.2	1.7
Sodium Dissolved (mg/l)	7.0	7.9	7.9
Alkalinity Total (mg/l)	132.	57.3	135.
Chloride Dissolved (mg/l)	15.0	15.0	16.0
Sulphate Dissolved (mg/l)	10.6	9.4	12.1
Phosphorus Total (mg/l)	0.050	0.19	0.08
Silica Reactive (mg/l)			
Manganese Extractable (mg/l)			
Iron Extractable (mg/l)			
Copper Extractable (mg/l)	L0.002		L0.002
Zinc Extractable(mg/l)	0.003		L0.002
Cadmium Extractable (mg/l)			L0.001
Lead Extractable (mg/l)	0.003		L0.002
Arsenic Total (mg/l)			L0.005
Carbon Total Org. (mg/l)	0.5	11.0	3.2
Carbon Total Inorg. (mg/l)			33.2
Nitrogen-NO_3 +NO_2 (mg/l)	1.7	0.15	2.6
Nitrogen-Ammonia Dis.(mg/l)	0.13	0.15	L0.005
Nitrogen-Total		1.6	
Phenolic Material (mg/l)			
Hydroc. Kerosene (mg/l)			
Hydroc. Jet Fuel (mg/l)			
Hydroc. Diesel Fuel (mg/l)			
Hydroc. Stove Oil (mg/l)			
Hydroc. Furnace Oil (mg/l)			
Hydroc Bunker Oil (mg/l)			
Hydroc. Gasoline-Reg. (mg/l)			
Urea (mg/l)		0.6	
Fluoride Dissolved			

Andrews Pond at spillway (dam)
NAQUADAT STN. NO. 01PE01CC0002

Field Parameters	Oct 13/76	Nov 30/76	Feb 9/77	Apr 4/77	July 26/77	Sept 21/77	Nov 8/77
Temp. Water (Deg. °C)					18.5		6.0
Spec. Conductance (USIE/cm)					340.		340.
pH (pH Units)					7.6		8.2
Hach D.O. (mg/l)							
Turbidity (JTU)	15	42	9		1.2	2.2	1.6
Depth of Water Table (m)							
Well pumped							

Lab Parameters							
Temp. Water (Lab) Deg. °C	25.	25.	25.	25.	25.	25.	25.
pH (pH units)	8.2	7.8	8.2	7.0	8.3	8.0	8.4
Spec. Conduct. (USIE/cm)	310.	210.	380.	192.	316.	295.	326.
Turbidity (JTU)	15.	42.		9.1	1.2	2.2	1.6
Colour Apparent (Rel. units)	30.	50.	L5.	25.	L5.	85.	5.
Calcium Dissolved (mg/l)	34.	17.5	34.	16.	31.	30.	26.
Magnesium Dissolved (mg/l)	17.5	8.6	18.2	8.2	19.	16.	19.
Potassium Dissolved (mg/l)	2.2	3.8	2.0	3.5	1.5	1.8	1.4
Sodium Dissolved (mg/l)	8.5	12.0	16.0	9.9	7.4	7.4	7.4
Alkalinity Total (mg/l)	134.	57.9	125.	57.4	124.		92.6
Chloride Dissolved (mg/l)	18.	21.	29.	19.	20.	13.	29.
Sulphate Dissolved (mg/l)	11.3	9.7	14.0	7.0	10.8	9.8	12.0
Phosphorus Total (mg/l)	0.37	0.25	0.08		0.020	0.040	0.047
Silica Reactive (mg/l)				2.2		3.9	6.0
Manganese Extractable (mg/l)							
Iron Extractable (mg/l)							
Copper Extractable (mg/l)	L0.002		L0.002				
Zinc Extractable(mg/l)	0.003		L0.002				
Cadmium Extractable (mg/l)			L0.001				
Lead Extractable (mg/l)	0.003		L0.002				
Arsenic Total (mg/l)			L0.005				
Carbon Total Org. (mg/l)	1.8	10.6	3.8	5.1	0.5	5.7	1.7
Carbon Total Inorg. (mg/l)			30.4	19.0	28.9	27.3	31.6
Nitrogen-NO_3+ NO_2 (mg/l)	1.82	1.62	4.0	0.88	1.7	2.3	3.6
Nitrogen-Ammonia Dis.(mg/l)		0.075	L0.005	0.10	L0.005	L0.005	L0.005
Nitrogen-Total		1.69		2.1	2.0	2.4	3.8
Phenolic Material (mg/l)							
Hydroc. Kerosene (mg/l)							
Hydroc. Jet Fuel (mg/l)							
Hydroc. Diesel Fuel (mg/l)							
Hydroc. Stove Oil (mg/l)							
Hydroc. Furnace Oil (mg/l)							
Hydroc Bunker Oil (mg/l)							
Hydroc. Gasoline-Reg. (mg/l)							
Urea (mg/l)							
Fluoride Dissolved	0.07			L0.05			

Andrews Pond at Spillway (dam)
NAQUADAT STN. NO. 01PE01CC0002

Field Parameters	Jan 30/78	Aug 29/78	Dec 5/78
Temp. Water (Deg. °C)	2.8		3.5
Spec. Conductance (USIE/cm)	300.		380.
pH (pH Units)	7.3		7.9
Hach D.O. (mg/1)			
Turbidity (JTU)	2.9	1.2	0.7
Depth of Water Table (m)			
Well pumped			
Lab Parameters			
Temp. Water (Lab) Deg. °C	25.	25.	25.
pH (pH units)	7.9	8.3	7.9
Spec. Conduct. (USIE/cm)	308.	366.	386.
Turbidity (JTU)	2.9	1.2	0.7
Colour Apparent (Rel. units)	10.	10.	L5.
Calcium Dissolved (mg/1)	25.5	36.	42.
Magnesium Dissolved (mg/1)	13.	19.	35.
Potassium Dissolved (mg/1)	1.9	1.6	1.3
Sodium Dissolved (mg/1)	14.	8.1	7.3
Alkalinity Total (mg/1)	86.2	137.	148.
Chloride Dissolved (mg/1)	28.	21.	20.
Sulphate Dissolved (mg/1)	10.0	12.0	12.0
Phosphorus Total (mg/1)	0.097	0.024	0.046
Silica Reactive (mg/1)	4.8	0.9	4.7
Manganese Extractable (mg/1)			
Iron Extractable (mg/1)			
Copper Extractable (mg/1)			
Zinc Extractable(mg/1)			
Cadmium Extractable (mg/1)			
Lead Extractable (mg/1)			
Arsenic Total (mg/1)			
Carbon Total Org. (mg/1)	L0.5	L0.5	4.0
Carbon Total Inorg. (mg/1)	25.7	41.	23.5
Nitrogen- NO_3 + NO_2 (mg/1)	3.0	1.9	3.6
Nitrogen-Ammonia Dis.(mg/1)	0.35	0.14	0.020
Nitrogen-Total	2.25	2.1	3.7
Phenolic Material (mg/1)			
Hydroc. Kerosene (mg/1)			
Hydroc. Jet Fuel (mg/1)			
Hydroc. Diesel Fuel (mg/1)			
Hydroc. Stove Oil (mg/1)			
Hydroc. Furnace Oil (mg/1)			
Hydroc Bunker Oil (mg/1)			
Hydroc. Gasoline-Reg. (mg/1)			
Urea (mg/1)			
Fluoride Dissolved			

Wrights Creek 500 m above Andrews Pond
NAQUADAT STN. NO. 00PE01CC0040

Field Parameters	Oct 13/76	Nov 30/76	Feb 9/77	Apr 4/77	July 26/77	Sept 21/77	Nov 8/77
Temp. Water (Deg. °C)					14.6		7.0
Spec. Conductance (USIE/cm)					380.		350.
pH (pH Units)					7.4		7.8
Hach D.O. (mg/l)							
Turbidity (JTU)							
Depth of Water Table (m)							
Well pumped							
Lab Parameters							
Temp Water (Lab) Deg. °C	25.	25.	25.		25.	25.	25.
pH (pH units)	8.1	7.7	8.3	7.2	8.4	8.3	8.4
Spec. Conduct. (USIE/cm)	335.	240.	365.	211.	310.	362.	348.
Turbidity (JTU)	22.	0.6		1.1	0.3	0.8	0.8
Colour Apparent (Rel. units)	30.	20.	L5.	15.	L5.	5.	L5.
Calcium Dissolved (mg/l)	41.	23.	38.	22.5	37.	40.	37.
Magnesium Dissolved (mg/l)	20.	12.	20	11.5	22.		20.
Potassium Dissolved (mg/l)	1.7	4.2	2.7	3.6	1.4	1.7	1.4
Sodium Dissolved (mg/l)	1.7	5.9	6.7	4.9	5.7	5.9	6.1
Alkalinity Total (mg/l)	168.	82.9	149.	77.7	145.	153.	135.
Chloride Dissolved (mg/l)	13.0	12.0	14.3	10.4	11.0	8.1	13.
Sulphate Dissolved (mg/l)	12.6	10.5	12.8	8.6	12.3	11.6	11.8
Phosphorus Total (mg/l)	0.47	0.19	0.07	0.16	0.075	0.061	0.050
Silica Reactive (mg/l)				2.8		6.0	6.4
Manganese Extractable (mg/l)							
Iron Extractable (mg/l)							
Copper Extractable (mg/l)	L0.002		L0.002				
Zinc Extractable(mg/l)	L0.002		L0.002				
Cadmium Extractable (mg/l)			L0.001				
Lead Extractable (mg/l)	L0.002		L0.002				
Arsenic Total (mg/l)			L0.005				
Carbon Total Org. (mg/l)	L0.5	8.5	3.7	6.6	1.9	6.3	1.0
Carbon Total Inorg. (mg/l)			35.3	22.7	23.7	36.3	32.6
Nitrogen-NO_3 + NO_2 (mg/l)	4.1	2.85	3.84	3.0	3.4	4.5	4.9
Nitrogen-Ammonia Dis.(mg/l)	L0.005	0.125	0.006	0.73	0.015	L0.005	L0.005
Nitrogen-Total		2.		3.9	3.6	3.8	4.9
Phenolic Material (mg/l)							
Hydroc. Kerosene (mg/l)							
Hydroc. Jet Fuel (mg/l)							
Hydroc. Diesel Fuel (mg/l)							
Hydroc. Stove Oil (mg/l)							
Hydroc. Furnace Oil (mg/l)							
Hydroc Bunker Oil (mg/l)							
Hydroc. Gasoline-Reg. (mg/l)							
Urea (mg/l)							
Fluoride Dissolved	.05			L0.05			

Wrights Creek above Andrews Pond
NAQUADAT STN. NO. 00PE01CC0040

Field Parameters	Jan 30/78	May 3/78	Dec 5/78	May 16/79	May 25/79	May 28/79	June 11/79
Temp. Water (Deg. °C)	3.4	6.5	5.8	9.0	8.5	9.5	9.5
Spec. Conductance (USIE/cm)	300.	300.	380.	370.	354.	348.	378.
pH (pH Units)	7.5	7.7	8.0	7.9	7.6	7.6	7.6
Hach D.O. (mg/1)				11.4	9.8	10.8	10.6
Turbidity (JTU)	.9	.9	.5	.4	0.7	1.2	0.7
Depth of Water Table (m)							
Well pumped							
Lab Parameters							
Temp Water (Lab) Deg. °C	25.	25.	25.	25.	25.	25.	25.
pH (pH units)	7.8	8.0	8.3	8.1	7.9	8.2	8.3
Spec. Conduct. (USIE/cm)	320.	302.	381.	371.	366.	352.	384.
Turbidity (JTU)	0.9	0.9	0.5	0.4	0.7	1.2	0.7
Colour Apparent (Rel. units)	5.	5.	5.	15.	L5.	L5.	L5.
Calcium Dissolved (mg/1)	32.	30.	42.	37.	33.	33.	35.
Magnesium Dissolved (mg/1)	17.	16.	35.	19.	19.	18.	19.
Potassium Dissolved (mg/1)	1.6	1.5	1.2	1.4	1.5	1.5	1.4
Sodium Dissolved (mg/1)	6.2	6.1	5.9	6.0	6.0	6.0	6.2
Alkalinity Total (mg/1)	116.	105.	159.	134.	136.	137.	141.
Chloride Dissolved (mg/1)	14.	15.0	12.0	11.0	16.	16.	10.
Sulphate Dissolved (mg/1)	11.3	10.8	12.3	10.7	12.	11.	11.
Phosphorus Total (mg/1)	0.067	0.060	0.052	0.043	0.043	0.043	0.052
Silica Reactive (mg/1)	5.6	4.6	5.2	5.5	5.2	5.6	6.2
Manganese Extractable (mg/1)				0.01	0.02	0.01	0.02
Iron Extractable (mg/1)				0.008	.022	0.027	0.034
Copper Extractable (mg/1)				L0.002	L.002	L0.002	L0.002
Zinc Extractable(mg/1)				L0.002	L0 002	L0.002	L0.002
Cadmium Extractable (mg/1)				L0.001	L0.001	L0.001	L0.001
Lead Extractable (mg/1)				L0.002	L0.002	L0.002	L0.002
Arsenic Total (mg/1)				L0.005	L0.005	L0.005	L0.005
Carbon Total Org. (mg/1)	L0.5	4.6	3.5	7.5	10.	8.5	19.0
Carbon Total Inorg. (mg/1)	30.8	28.0	26.5	34.5	37.0	35.0	15.5
Nitrogen-NO_3 + NO_2 (mg/1)	5.0	DE.	4.5	5.7	5.2	5.2	5.7
Nitrogen-Ammonia Dis.(mg/1)	0.13	IN.	L0.005	L0.005	L0.005	L0.005	L0.005
Nitrogen-Total	5.3	IN.	4.1	6.1	6.4	5.9	DE.
Phenolic Material (mg/1)							
Hydroc. Kerosene (mg/1)							
Hydroc. Jet Fuel (mg/1)							
Hydroc. Diesel Fuel (mg/1)							
Hydroc. Stove Oil (mg/1)							
Hydroc. Furnace Oil (mg/1)							
Hydroc Bunker Oil (mg/1)							
Hydroc. Gasoline-Reg. (mg/1)							
Urea (mg/1)				.02	.02	.02	DE.
Fluoride Dissolved				.05	L0.05	L0.05	L0.05

Wrights Creek above Andrews Pond
NAQUADAT STN. NO. 00PE01CC0040

Field Parameters	June 25/79	July 4/79	July 6/79	July 9/79	July 18/79	July 2/79	Aug 6/79
Temp. Water (Deg. °C)	8.5	12.0	10.	11.	11.5	14.0	12.0
Spec. Conductance (USIE/cm)	396.	400.	352	374.	314.	360.	362.
pH (pH Units)	7.6	8.0	8.1	7.7	7.5	7.6	7.6
Hach D.O. (mg/1)	9.8	10.6	9.8	9.8	9.6	10.2	9.8
Turbidity (JTU)	0.3	0.4	7.2	1.6	23.	0.9	0.8
Depth of Water Table (m)							
Well pumped							
Lab Parameters							
Temp Water (Lab) Deg. °C	25.	25.	25.	26.	25.	25.	25.
pH (pH units)	8.2	8.3	8.1	8.2	8.4	7.9	8.1
Spec. Conduct. (USIE/cm)	399.	391.	342.	378.	315.	385.	335.
Turbidity (JTU)	335	0.4	7.2	1.6	23.	0.9	0.8
Colour Apparent (Rel. units)	L5.	L5.	5.	L5.	5.	5.	5.
Calcium Dissolved (mg/1)	38.	37.	33.	35.	30.	38.	38.
Magnesium Dissolved (mg/1)	24.	20.	18.	19.	18.	20.	19.
Potassium Dissolved (mg/1)	1.1	1.2	1.3	1.2	2.1	1.4	1.4
Sodium Dissolved (mg/1)	6.1	6.2	5.6	6.0	5.4	6.2	5.9
Alkalinity Total (mg/1)	150.	157.	131.	145.	119.	143.	144.
Chloride Dissolved (mg/1)	10.	12.	11.	11.	12.	13.	13.
Sulphate Dissolved (mg/1)	11.	11.	10.	10.	10.	11.	12.
Phosphorus Total (mg/1)	0.052	0.052	0.13	0.055	0.090	0.075	0.070
Silica Reactive (mg/1)	5.0	5.1	5.0	5.3	4.5	6.0	5.9
Manganese Extractable (mg/1)	L0.01		L0.01	L0.01	0.02	0.01	0.01
Iron Extractable (mg/1)	0.006	0.025	0.42	0.040	0.32	0.044	0.10
Copper Extractable (mg/1)	L0.002	L0.002	L0.002	L0.002	0.009	L0.002	0.003
Zinc Extractable(mg/1)	L0.002	L0.002	L0.002	L0.002	0.003	L0.002	0.002
Cadmium Extractable (mg/1)	L0.001						
Lead Extractable (mg/1)	L0.002		L0.002	L0.002	L0.002	L0.002	0.002
Arsenic Total (mg/1)	L0.005						
Carbon Total Org. (mg/1)	13.5	12.0	12.0	11.0	14.0	11.0	12.0
Carbon Total Inorg. (mg/1)	32.0	31.0	29.5	27.5	21.5	32.5	31.0
Nitrogen-NO_3 + NO_2 (mg/1)	DE.	5.0	4.3	DE.	DE.	4.9	4.8
Nitrogen-Ammonia Dis.(mg/1)	L0.005	L0.005	L0.005	L0.005	L0.005	0.015	0.005
Nitrogen-Total	DE.	DE.	DE.	DE.	DE.		5.4
Phenolic Material (mg/1)							
Hydroc. Kerosene (mg/1)			L0.5	L0.5			
Hydroc. Jet Fuel (mg/1)			L0.5	L0.5			
Hydroc. Diesel Fuel (mg/1)			L0.5	L0.5			
Hydroc. Stove Oil (mg/1)			L0.5	L0.5			
Hydroc. Furnace Oil (mg/1)			L0.5	L0.5			
Hydroc Bunker Oil (mg/1)			L0.5	L0.5			
Hydroc. Gasoline-Reg. (mg/1)			L0.5	L0.5			
Urea (mg/1)	DE.	DE.	DE.	DE.	DE.	DE.	DE.
Fluoride Dissolved	L0.5						

Wrights Creek above Andrews Pond
NAQUADAT STN. NO. 00PE01CC0040

Field Parameters	Aug 22/79	Sept 5/79	Sept 17/79	Oct 2/79	Oct 15/79	Oct 29/79	Nov 9/79
Temp. Water (Deg. °C)	11.0	8.5	11.0	13.	8.5	8.0	8.5
Spec. Conductance (USIE/cm)	382.			124.	344.	360.	356.
pH (pH Units)	7.8	7.6	7.6	6.6	7.5	7.5	7.5
Hach D.O. (mg/l)	19.6	10.8	10.4	9.4	10.4	11.8	9.6
Turbidity (JTU)	1.3	1.4	2.5	86.	2.9	3.3	
Depth of Water Table (m)							
Well pumped							

Lab Parameters	Aug 22/79	Sept 5/79	Sept 17/79	Oct 2/79	Oct 15/79	Oct 29/79	Nov 9/79
Temp Water (Lab) Deg. °C	25.	25.	25.	25.	25.	25.	25.
pH (pH units)	8.0	8.0	8.3	7.3	8.2	8.6	8.1
Spec. Conduct. (USIE/cm)	365.	384.	386.	120.	352.	364.	354.
Turbidity (JTU)	0.7	0.1	2.3	110.	0.9	0.6	1.8
Colour Apparent (Rel. units)	L5.	L5.	5.	40.	L5.	L5.	L5.
Calcium Dissolved (mg/l)	38.	38.	37.	10.	34.	37.	36.
Magnesium Dissolved (mg/l)	19.	20.	20.	4.7	18.	20.	18.
Potassium Dissolved (mg/l)	1.3	1.2	1.5	3.3	1.4	1.3	1.5
Sodium Dissolved (mg/l)	6.1	5.7	6.2	2.7	5.9	6.1	6.2
Alkalinity Total (mg/l)	139.	147.	143.	36.9	134.	139.	130.
Chloride Dissolved (mg/l)	12.	10.	10.	4.8	10.0	10.2	10.2
Sulphate Dissolved (mg/l)	8.7	11.	10.8	4.8	11.1	11.3	11.3
Phosphorus Total (mg/l)	0.046	0.047	0.052	0.35	0.060	0.055	0.062
Silica Reactive (mg/l)	3.5	6.5	6.0	2.0	5.6	5.4	4.6
Manganese Extractable (mg/l)	0.01		0.01	0.21	0.03	0.02	0.03
Iron Extractable (mg/l)	0.069	0.017	0.10	0.70	0.10	0.05	0.10
Copper Extractable (mg/l)	0.003	L0.002	0.002	L0.002	L0.002	L0.002	L0.002
Zinc Extractable(mg/l)	L0.002	L0.002	0.005	0.011	0.055	0.002	0.002
Cadmium Extractable (mg/l)							
Lead Extractable (mg/l)	0.002		L0.002	0.002	L0.002	L0.002	L0.002
Arsenic Total (mg/l)							
Carbon Total Org. (mg/l)	11.0	17.5	10.9	17.0	5.5	5.0	6.0
Carbon Total Inorg. (mg/l)	32.5	27.0	28.0	7.5	34.0	35.5	32.5
Nitrogen-NO_3 + NO_2 (mg/l)	5.0	4.9	5.0	1.5	4.3	5.0	4.8
Nitrogen-Ammonia Dis.(mg/l)	0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005
Nitrogen-Total	6.2	5.7	6.2	1.6		5.5	
Phenolic Material (mg/l)							
Hydroc. Kerosene (mg/l)							
Hydroc. Jet Fuel (mg/l)							
Hydroc. Diesel Fuel (mg/l)							
Hydroc. Stove Oil (mg/l)							
Hydroc. Furnace Oil (mg/l)							
Hydroc Bunker Oil (mg/l)							
Hydroc. Gasoline-Reg. (mg/l)							
Urea (mg/l)	DE.	L0.01	L0.01	0.10	0.02	0.04	0.03
Fluoride Dissolved							

Wrights Creek above Andrews Pond
NAQUADAT STN. NO. 00PE01CC0040

Field Parameters	Nov 15/79	Dec 10/79	Dec 24/79	Jan 14/80	Jan 21/80	Feb 6/80	Feb 26/80
Temp. Water (Deg. °C)	6.0	5.5	6.0	5.5	4.0	6.0	5.0
Spec. Conductance (USIE/cm)	208.	346.	356.	348.	368.	314.	386.
pH (pH Units)	7.1	7.5	7.6	7.7	7.7	8.1	7.7
Hach D.O. (mg/l)	10.2	11.2	11.4	13.2	10.6	7.7	11.8
Turbidity (JTU)	17.	3.8	2.2	3.7	1.7	0.7	0.7
Depth of Water Table (m)							
Well pumped							
Lab Parameters							
Temp Water (Lab) Deg. °C	25.	25.	25.	25.	25.	25.	25.
pH (pH units)	7.8	7.9	8.3	8.0	7.9	8.1	8.0
Spec. Conduct. (USIE/cm)	217.	347.	363.	348.	372.	387.	402.
Turbidity (JTU)	17.	1.5	0.3	1.6	0.3	0.2	0.2
Colour Apparent (Rel. units)	10.	L5.	L5.	L5.	L5.	L5.	L5.
Calcium Dissolved (mg/l)	21.	35.	37.	35.	37.	39.	40.
Magnesium Dissolved (mg/l)	11.	18.	18.	17.	17.	19.	21.
Potassium Dissolved (mg/l)	1.7	1.1	1.2	1.4	1.3	1.3	1.3
Sodium Dissolved (mg/l)	4.2	6.3	6.3	6.9	6.3	6.3	6.5
Alkalinity Total (mg/l)	74.	130.	133.	118.	135.	147.	150.
Chloride Dissolved (mg/l)	8.0	10.0	13.	14.	12.0	13.0	14.5
Sulphate Dissolved (mg/l)	7.5	11.0	11.	10.5	10.5	10.5	11.8
Phosphorus Total (mg/l)	0.14				0.058	0.059	.055
Silica Reactive (mg/l)	3.8				6.4	6.4	6.7
Manganese Extractable (mg/l)	0.04	0.02	0.02	0.02	0.01	0.01	0.01
Iron Extractable (mg/l)	0.30	0.056	0.046	0.047	0.029	0.033	.015
Copper Extractable (mg/l)	0.002	L0.002	L0.002	L0.002	L0.002	L0.002	L0.002
Zinc Extractable(mg/l)	0.006	L0.002	L0.002	L0.002	L0.002	L0.002	L0.002
Cadmium Extractable (mg/l)							
Lead Extractable (mg/l)	L0.002	L0.002	L0.002	L0.002	L0.002	L0.002	L0.002
Arsenic Total (mg/l)							
Carbon Total Org. (mg/l)	6.5	6.0	6.0	5.5	10.0	8.5	1.5
Carbon Total Inorg. (mg/l)	20.0	32.5	34.0	32.5	31.5	33.5	40.5
Nitrogen-NO_3 + NO_2 (mg/l)	2.8	5.8	6.4	6.2	5.8	5.6	6.0
Nitrogen-Ammonia Dis.(mg/l)	0.010	L0.005	0.025	0.15	L0.005	L0.005	L0.005
Nitrogen-Total	3.6			6.8	5.9	5.8	6.7
Phenolic Material (mg/l)							
Hydroc. Kerosene (mg/l)							
Hydroc. Jet Fuel (mg/l)							
Hydroc. Diesel Fuel (mg/l)							
Hydroc. Stove Oil (mg/l)							
Hydroc. Furnace Oil (mg/l)							
Hydroc Bunker Oil (mg/l)							
Hydroc. Gasoline-Reg. (mg/l)							
Urea (mg/l)	0.07	L0.01	L0.01	0.85	0.06	L0.01	L0.01
Fluoride Dissolved							

Wrights Creek above Andrews Pond
NAQUADAT STN. NO. 00PE01CC0040

Field Parameters	Mar 7/80
Temp. Water (Deg. °C)	7.0
Spec. Conductance (USIE/cm)	386.
pH (pH Units)	7.7
Hach D.O. (mg/1)	10.2
Turbidity (JTU)	1.0
Depth of Water Table (m)	
Well pumped	

Lab Parameters	
Temp Water (Lab) Deg. °C	25.
pH (pH units)	8.2
Spec. Conduct. (USIE/cm)	401.
Turbidity (JTU)	0.2
Colour Apparent (Rel. units)	L5.
Calcium Dissolved (mg/1)	40.
Magnesium Dissolved (mg/1)	22.
Potassium Dissolved (mg/1)	1.4
Sodium Dissolved (mg/1)	6.5
Alkalinity Total (mg/1)	152.
Chloride Dissolved (mg/1)	12.5
Sulphate Dissolved (mg/1)	11.8
Phosphorus Total (mg/1)	0.056
Silica Reactive (mg/1)	6.5
Manganese Extractable (mg/1)	0.01
Iron Extractable (mg/1)	0.017
Copper Extractable (mg/1)	L0.002
Zinc Extractable(mg/1)	L0.002
Cadmium Extractable (mg/1)	
Lead Extractable (mg/1)	L0.002
Arsenic Total (mg/1)	
Carbon Total Org. (mg/1)	2.5
Carbon Total Inorg. (mg/1)	44.0
Nitrogen-NO_3 + NO_2 (mg/1)	5.8
Nitrogen-Ammonia Dis.(mg/1)	0.025
Nitrogen-Total	8.3
Phenolic Material (mg/1)	
Hydroc. Kerosene (mg/1)	
Hydroc. Jet Fuel (mg/1)	
Hydroc. Diesel Fuel (mg/1)	
Hydroc. Stove Oil (mg/1)	
Hydroc. Furnace Oil (mg/1)	
Hydroc Bunker Oil (mg/1)	
Hydroc. Gasoline-Reg. (mg/1)	
Urea (mg/1)	.03
Fluoride Dissolved	

Charlottetown Airport Test Well #1 near beacon, Depth - 13.93 m
NAQUADAT STN. NO. 10PE01CC0031

Field Parameters	Dec 1/80
Temp. Water (Deg. °C)	
Spec. Conductance (USIE/cm)	
pH (pH Units)	
Hach D.O. (mg/l)	
Turbidity (JTU)	
Depth of Water Table (m)	
Well pumped	

Lab Parameters

Temp Water (Lab) Deg. °C	25.
pH (pH units)	8.5
Spec. Conduct. (USIE/cm)	400.
Turbidity (JTU)	33.
Colour Apparent (Rel. units)	
Calcium Dissolved (mg/l)	56.
Magnesium Dissolved (mg/l)	29.
Potassium Dissolved (mg/l)	3.6
Sodium Dissolved (mg/l)	4.8
Alkalinity Total (mg/l)	222.
Chloride Dissolved (mg/l)	8.7
Sulphate Dissolved (mg/l)	10.5
Phosphorus Total (mg/l)	0.16
Silica Reactive (mg/l)	
Manganese Extractable (mg/l)	
Iron Extractable (mg/l)	
Copper Extractable (mg/l)	
Zinc Extractable(mg/l)	
Cadmium Extractable (mg/l)	
Lead Extractable (mg/l)	
Arsenic Total (mg/l)	
Carbon Total Org. (mg/l)	10.2
Carbon Total Inorg. (mg/l)	
Nitrogen-NO_3+NO_2 (mg/l)	2.7
Nitrogen-Ammonia Dis.(mg/l)	L0.005
Nitrogen-Total	3.0
Phenolic Material (mg/l)	L0.002
Hydroc. Kerosene (mg/l)	L0.5
Hydroc. Jet Fuel (mg/l)	
Hydroc. Diesel Fuel (mg/l)	
Hydroc. Stove Oil (mg/l)	
Hydroc. Furnace Oil (mg/l)	
Hydroc Bunker Oil (mg/l)	
Hydroc. Gasoline-Reg. (mg/l)	L0.5
Urea (mg/l)	
Fluoride Dissolved	

Charlottetown Airport Test Well #2 off Terminal Bldg. apron
NAQUADAT STN. NO. 10PE01CC0032

Field Parameters	Sept 16/76	Dec 1/76	Feb 9/77	July 27/77	Sept 20/77	Nov 9/77
Temp. Water (Deg. °C)						7.5
Spec. Conductance (USIE/cm)						280.
pH (pH Units)						7.2
Hach D.O. (mg/1)						
Turbidity (JTU)						
Depth of Water Table (m)						
Well pumped	No	Yes	No	No	Yes	Yes
Lab Parameters						
Temp Water (Lab) Deg. °C	25.	25.	25.	25.	25.	25.
pH (pH units)	7.5	7.9	8.3	8.2	7.7	8.4
Spec. Conduct. (USIE/cm)	335.	289.	350.	280.	288.	278.
Turbidity (JTU)	8.0	43.	66.	59.	1.7	G25.
Colour Apparent (Rel. units)	L5.	L5.	G100.0	L5.	L5.	L5.
Calcium Dissolved (mg/1)	38.0	31.5	38.0	32.0	32.	32.
Magnesium Dissolved (mg/1)	19.0	22.0	19.5	18.	18.	18.
Potassium Dissolved (mg/1)	1.4	1.9	1.8	1.4	1.3	1.3
Sodium Dissolved (mg/1)	4.4	4.1	5.1	3.8	3.6	3.7
Alkalinity Total (mg/1)	158.	144.	179.	136.	143.	136.
Chloride Dissolved (mg/1)	5.2	6.0	6.0	7.0	6.0	6.0
Sulphate Dissolved (mg/1)	7.7	7.3	6.6	7.5	7.5	7.5
Phosphorus Total (mg/1)	0.50	0.70	0.32	0.22	0.15	0.11
Silica Reactive (mg/1)			7.5		7.0	7.7
Manganese Extractable (mg/1)			0.01			
Iron Extractable (mg/1)			1.4			
Copper Extractable (mg/1)						
Zinc Extractable(mg/1)						
Cadmium Extractable (mg/1)						
Lead Extractable (mg/1)						
Arsenic Total (mg/1)						
Carbon Total Org. (mg/1)	10.5	8.8	8.6	0.5	4.7	2.6
Carbon Total Inorg. (mg/1)			39.3	36.3	33.4	37.2
Nitrogen-NO_3 + NO_2 (mg/1)	1.80	0.90	1.21	1.2	0.65	0.79
Nitrogen-Ammonia Dis.(mg/1)	0.025	L0.005	L0.005	L0.005	L0.005	L0.005
Nitrogen-Total	1.82	0.99	1.21	1.3	0.65	0.76
Phenolic Material (mg/1)	0.002	0.007			L0.002	L0.002
Hydroc. Kerosene (mg/1)		L0.5				
Hydroc. Jet Fuel (mg/1)						
Hydroc. Diesel Fuel (mg/1)						
Hydroc. Stove Oil (mg/1)						
Hydroc. Furnace Oil (mg/1)						
Hydroc Bunker Oil (mg/1)						
Hydroc. Gasoline-Reg. (mg/1)		L0.5				
Urea (mg/1)			L0.01		L0.01	L0.01
Fluoride Dissolved	0.11					

Charlottetown Airport Test Well #2 off Terminal Bldg. apron
NAQUADAT STN. NO. 01PE01CC0032

Field Parameters	May 4/77	Aug 29/78
Temp. Water (Deg. °C)	7.5	
Spec. Conductance (USIE/cm)	240.	
pH (pH Units)	6.8	
Hach D.O. (mg/l)	8.6	
Turbidity (JTU)		
Depth of Water Table (m)		
Well pumped	No	No

Lab Parameters		
Temp Water (Lab) Deg. °C	25.	25.
pH (pH units)	7.7	7.5
Spec. Conduct. (USIE/cm)	245.	337.
Turbidity (JTU)	64.	G25.
Colour Apparent (Rel. units)	10.	5.
Calcium Dissolved (mg/l)	26.	37.
Magnesium Dissolved (mg/l)	14.	20.
Potassium Dissolved (mg/l)	1.3	1.5
Sodium Dissolved (mg/l)	3.8	4.6
Alkalinity Total (mg/l)	104.	160.
Chloride Dissolved (mg/l)	5.6	5.7
Sulphate Dissolved (mg/l)	7.0	7.0
Phosphorus Total (mg/l)	0.19	0.11
Silica Reactive (mg/l)	7.3	6.7
Manganese Extractable (mg/l)		
Iron Extractable (mg/l)		
Copper Extractable (mg/l)		
Zinc Extractable(mg/l)		
Cadmium Extractable (mg/l)		
Lead Extractable (mg/l)		
Arsenic Total (mg/l)		
Carbon Total Org. (mg/l)	5.5	0.5
Carbon Total Inorg. (mg/l)	30.5	46.0
Nitrogen-NO_3 + NO_2 (mg/l)	DE.	1.2
Nitrogen-Ammonia Dis.(mg/l)	IN.	0.010
Nitrogen-Total	IN.	1.3
Phenolic Material (mg/l)	LO.002	IN.
Hydroc. Kerosene (mg/l)		
Hydroc. Jet Fuel (mg/l)		
Hydroc. Diesel Fuel (mg/l)		
Hydroc. Stove Oil (mg/l)		
Hydroc. Furnace Oil (mg/l)	LO.5	
Hydroc Bunker Oil (mg/l)		
Hydroc. Gasoline-Reg. (mg/l)	LO.5	
Urea (mg/l)	0.05	IN.
Fluoride Dissolved		

Charlottetown Airport Test Well #3, Depth - 15.34 m
NAQUADAT STN. NO. 10PE01CC0033

Field Parameters	Sept 16/76	Dec 1/76	Feb 9/77	Apr 6/77	Jan 31/78
Temp. Water (Deg. °C)					6.5
Spec. Conductance (USIE/cm)					438.
pH (pH Units)					6.6
Hach D.O. (mg/l)					
Turbidity (JTU)	35	33.	51.	53.	15.
Depth of Water Table (m)					
Well pumped	No	Yes	No	Yes	No
Lab Parameters					
Temp Water (Lab) Deg. °C	25.	25.	25.	25.	25.
pH (pH units)	8.2	8.5	7.8	8.3	6.6
Spec. Conduct. (USIE/cm)	440.	365.	480.	345.0	459.
Turbidity (JTU)	35.	33.	51.	53.	15.
Colour Apparent (Rel. units)	L5.	30.		5.	G100.
Calcium Dissolved (mg/l)	41.	45.	49.5	38.5	52.
Magnesium Dissolved (mg/l)	26.8	24.0	31.0	20.0	3.9
Potassium Dissolved (mg/l)	1.6	1.7	1.8	1.3	1.9
Sodium Dissolved (mg/l)	4.8	4.3	4.9	4.1	5.0
Alkalinity Total (mg/l)	228.	191.	233.	167.	208.
Chloride Dissolved (mg/l)	6.3	6.7	9.4	6.5	11.
Sulphate Dissolved (mg/l)	8.2	7.3	9.5	7.1	12.0
Phosphorus Total (mg/l)	0.50	0.15	0.10	0.22	0.22
Silica Reactive (mg/l)			7.2	4.3	7.8
Manganese Extractable (mg/l)			0.02		
Iron Extractable (mg/l)			0.70		
Copper Extractable (mg/l)					
Zinc Extractable(mg/l)					
Cadmium Extractable (mg/l)					
Lead Extractable (mg/l)					
Arsenic Total (mg/l)					
Carbon Total Org. (mg/l)	11.5	10.0	10.8	2.1	1.6
Carbon Total Inorg. (mg/l)			53.1	43.7	58.4
Nitrogen-NO_3 + NO_2 (mg/l)	2.8	1.85	3.0	2.0	5.0
Nitrogen-Ammonia Dis.(mg/l)	0.020	L0.005	L0.005	0.010	L0.005
Nitrogen-Total	3.6	2.0	3.4	2.0	6.8
Phenolic Material (mg/l)	L0.002	0.009		0.002	
Hydroc. Kerosene (mg/l)		L0.5			
Hydroc. Jet Fuel (mg/l)					
Hydroc. Diesel Fuel (mg/l)					
Hydroc. Stove Oil (mg/l)					
Hydroc. Furnace Oil (mg/l)					
Hydroc Bunker Oil (mg/l)					
Hydroc. Gasoline-Reg. (mg/l)		L0.5			
Urea (mg/l)			L0.01	0.04	0.08
Fluoride Dissolved	0.06			0.06	

Charlottetown Airport Test Well #4 west of old hanger, Well Depth - 11.29 m
NAQUADAT STN. NO. 10PE01CC0034

Field Parameters	Sept 16/76	Nov 29/76	Apr 6/77
Temp. Water (Deg. °C)			
Spec. Conductance (USIE/cm)			
pH (pH Units)			
Hach D.O. (mg/1)			
Turbidity (JTU)	51.	36.	49.0
Depth of Water Table (m)	5.95*	4.985	5.74
Well pumped	No	Yes	Yes
Lab Parameters			
Temp Water (Lab) Deg. °C	25.	25.	
pH (pH units)	8.2	8.1	8.3
Spec. Conduct. (USIE/cm)	485.	430.	461.
Turbidity (JTU)	51.	36.	49.
Colour Apparent (Rel. units)	10.	L5.	L5.
Calcium Dissolved (mg/1)	58.	52.5	57.5
Magnesium Dissolved (mg/1)	32.0	21.5	29.0
Potassium Dissolved (mg/1)	2.3	3.6	1.8
Sodium Dissolved (mg/1)	4.7	4.6	4.8
Alkalinity Total (mg/1)	232.	199.	238.
Chloride Dissolved (mg/1)	6.8	8.0	6.8
Sulphate Dissolved (mg/1)	11.5	11.0	11.0
Phosphorus Total (mg/1)	0.50	0.12	0.22
Silica Reactive (mg/1)			4.5
Manganese Extractable (mg/1)			
Iron Extractable (mg/1)			
Copper Extractable (mg/1)			
Zinc Extractable(mg/1)			
Cadmium Extractable (mg/1)			
Lead Extractable (mg/1)			
Arsenic Total (mg/1)			
Carbon Total Org. (mg/1)	39.2	9.0	2.8
Carbon Total Inorg. (mg/1)			55.9
Nitrogen-NO_3 + NO_2 (mg/1)	2.8	3.65	4.1
Nitrogen-Ammonia Dis.(mg/1)	0.55	L0.005	0.005
Nitrogen-Total	3.4		4.5
Phenolic Material (mg/1)	0.004	L0.002	0.004
Hydroc. Kerosene (mg/1)		L0.5	
Hydroc. Jet Fuel (mg/1)			
Hydroc. Diesel Fuel (mg/1)			
Hydroc. Stove Oil (mg/1)			
Hydroc. Furnace Oil (mg/1)			
Hydroc Bunker Oil (mg/1)			
Hydroc. Gasoline-Reg. (mg/1)		L0.5	
Urea (mg/1)			0.02
Fluoride Dissolved	0.05		L0.05

Charlottetown Airport Test Well #5 at fire training area, Depth - 10.68 m
NAQUADAT STN. NO. 10PE01CC0035

Field Parameters	Sept 16/76	Dec 1/76	Feb 9/77	Apr 6/77	July 26/77	Sept 20/77	Nov 8/77
Temp. Water (Deg. °C)							9.0
Spec. Conductance (USIE/cm)							430.
pH (pH Units)							6.2
Hach D.O. (mg/1)							
Turbidity (JTU)	64.	28.	22.	16.	23.	17.	G25.
Depth of Water Table (m)	6.29*	4.91	6.495	5.945	6.285	5.69	3.54
Well pumped	No	Yes	No	Yes	No	Unknown	Yes

Lab Parameters	Sept 16/76	Dec 1/76	Feb 9/77	Apr 6/77	July 26/77	Sept 20/77	Nov 8/77
Temp Water (Lab) Deg. °C	25.	25.	25.		25.	25.	25.
pH (pH units)	6.5	7.6	7.5	7.7	8.2	6.7	7.6
Spec. Conduct. (USIE/cm)	415.	252.	300.	250.	315.	400.	312.
Turbidity (JTU)	64.	28.	22.	16.	23.	17.	G25.
Colour Apparent (Rel. units)	5.	L5.	5.	5.	L5.	5.	10.
Calcium Dissolved (mg/1)	33.0	21.0	25.0	22.5	29.0	29.0	30.0
Magnesium Dissolved (mg/1)	11.4	6.7	7.5	7.2	9.0	9.0	7.0
Potassium Dissolved (mg/1)	8.9	9.0	7.3	4.9	7.8	11.	9.0
Sodium Dissolved (mg/1)	15.0	6.9	7.6	6.4	8.5	12.	8.0
Alkalinity Total (mg/1)	94.9	36.0	35.3	21.0	95.0	133.0	70.1
Chloride Dissolved (mg/1)	38.0	32.0	32.0	47.0	37.0	35.0	33.0
Sulphate Dissolved (mg/1)	25.0	19.8	18.0	14.0	18.5	21.8	26.2
Phosphorus Total (mg/1)		0.027	0.018	0.025	0.010		0.011
Silica Reactive (mg/1)			5.6	3.6		3.9	4.7
Manganese Extractable (mg/1)			9.2				
Iron Extractable (mg/1)			2.0				
Copper Extractable (mg/1)							
Zinc Extractable(mg/1)							
Cadmium Extractable (mg/1)							
Lead Extractable (mg/1)							
Arsenic Total (mg/1)							
Carbon Total Org. (mg/1)	37.2	13.3	7.6	2.5	3.6	14.0	5.9
Carbon Total Inorg. (mg/1)			20.7	9.4	23.7	30.5	31.3
Nitrogen-NO_3 + NO_2 (mg/1)	0.01	1.9	1.63	2.5	1.0	L0.010	0.010
Nitrogen-Ammonia Dis.(mg/1)	4.5	0.42	3.0	1.53	0.15	5.0	
Nitrogen-Total	4.8	4.45	2.84	4.2	1.7	4.5	3.5
Phenolic Material (mg/1)	0.007	0.017		0.002		0.003	0.009
Hydroc. Kerosene (mg/1)		L0.5					
Hydroc. Jet Fuel (mg/1)							
Hydroc. Diesel Fuel (mg/1)							
Hydroc. Stove Oil (mg/1)							
Hydroc. Furnace Oil (mg/1)							
Hydroc Bunker Oil (mg/1)							
Hydroc. Gasoline-Reg. (mg/1)		L0.5					
Urea (mg/1)			0.05	0.09		0.09	L0.01
Fluoride Dissolved	0.13			0.14			

Charlottetown Airport Test Well #5 at fire training area
NAQUADAT STN. NO. 10PE01CC0035

Field Parameters	Jan 31/78	May 4/78	Aug 29/78	Dec 6/78
Temp. Water (Deg. °C)	6.5	7.0		8.5
Spec. Conductance (USIE/cm)	420.	360.		510.
pH (pH Units)	6.1	6.0		
Hach D.O. (mg/l)		0.2		
Turbidity (JTU)	33.	26.	23.	G25.
Depth of Water Table (m)			6.86	
Well pumped	No	No	No	No
Lab Parameters				
Temp Water (Lab) Deg. °C	25.	25.	25.	25.
pH (pH units)	6.2	6.2	8.3	7.4
Spec. Conduct. (USIE/cm)	359.	328.	320.	344.
Turbidity (JTU)	33.	26.	23.	25.
Colour Apparent (Rel. units)	65.	5.	5.	IN.
Calcium Dissolved (mg/l)	25.0	26.0	25.0	29.0
Magnesium Dissolved (mg/l)	4.9	14.	7.5	7.5
Potassium Dissolved (mg/l)	9.0	7.0	8.5	4.5
Sodium Dissolved (mg/l)	10.0	7.9	8.0	16.0
Alkalinity Total (mg/l)	90.4	69.	87.	98.
Chloride Dissolved (mg/l)	30.0	41.4	33.0	37.0
Sulphate Dissolved (mg/l)	17.4	30.0	19.1	32.3
Phosphorus Total (mg/l)	0.030	0.030	0.20	0.040
Silica Reactive (mg/l)	3.9	4.4	4.9	4.0
Manganese Extractable (mg/l)				
Iron Extractable (mg/l)				
Copper Extractable (mg/l)				
Zinc Extractable(mg/l)				
Cadmium Extractable (mg/l)				
Lead Extractable (mg/l)				
Arsenic Total (mg/l)				
Carbon Total Org. (mg/l)	4.5	46.6	3.0	11.5
Carbon Total Inorg. (mg/l)	25.2	50.0	26.0	16.5
Nitrogen-NO_3 + NO_2 (mg/l)	LO.01	DE.	0.43	0.29
Nitrogen-Ammonia Dis.(mg/l)	7.3	IN.	6.0	
Nitrogen-Total	2.10	IN.	3.8	1.2
Phenolic Material (mg/l)		0.002	IN.	0.005
Hydroc. Kerosene (mg/l)		LO.5		
Hydroc. Jet Fuel (mg/l)				
Hydroc. Diesel Fuel (mg/l)				
Hydroc. Stove Oil (mg/l)				
Hydroc. Furnace Oil (mg/l)		LO.5		
Hydroc Bunker Oil (mg/l)				
Hydroc. Gasoline-Reg. (mg/l)		LO.5		
Urea (mg/l)	0.08	0.03	IN.	0.08
Fluoride Dissolved				

Charlottetown Airport Test Well #6, Depth - 12.59m
NAQUADAT STN. NO. 10PE01CC0036

Field Parameters	Sept 16/76	Nov 29/76	Feb 9/77	Apr 5/77
Temp. Water (Deg. °C)				
Spec. Conductance (USIE/cm)				
pH (pH Units)				
Hach D.O. (mg/1)				
Turbidity (JTU)	32.	4.4	6.3	11.0
Depth of Water Table (m)	6.53*	2.5	6.34	
Well pumped	No	6.9		Yes
Lab Parameters				
Temp Water (Lab) Deg. °C	25.	25.	25.	
pH (pH units)	7.7	6.9	8.1	7.7
Spec. Conduct. (USIE/cm)	490.	105.	460.	432.
Turbidity (JTU)	32.		6.3	11.
Colour Apparent (Rel. units)	15.	L5	5.	L5.
Calcium Dissolved (mg/1)	50.0	6.0	50.0	46.0
Magnesium Dissolved (mg/1)	30.0	3.4	30.0	24.2
Potassium Dissolved (mg/1)	2.1	3.8	2.1	2.1
Sodium Dissolved (mg/1)	4.9	3.6	4.6	4.4
Alkalinity Total (mg/1)	240.	9.2	231.	196.
Chloride Dissolved (mg/1)	6.4	7.0	7.4	7.7
Sulphate Dissolved (mg/1)	10.0	6.0	11.0	10.9
Phosphorus Total (mg/1)	0.40	.18	0.18	0.12
Silica Reactive (mg/1)			7.3	4.4
Manganese Extractable (mg/1)			0.01	
Iron Extractable (mg/1)			0.02	
Copper Extractable (mg/1)				
Zinc Extractable(mg/1)				
Cadmium Extractable (mg/1)				
Lead Extractable (mg/1)				
Arsenic Total (mg/1)				
Carbon Total Org. (mg/1)	54.4	6.5	7.4	0.9
Carbon Total Inorg. (mg/1)			41.4	48.6
Nitrogen-NO_3 + NO_2 (mg/1)	2.5	5.35	2.76	1.89
Nitrogen-Ammonia Dis.(mg/1)	0.035	L0.005	L0.005	0.005
Nitrogen-Total	2.5	5.35	2.64	1.90
Phenolic Material (mg/1)	L0.002	L0.002		L0.002
Hydroc. Kerosene (mg/1)				
Hydroc. Jet Fuel (mg/1)				
Hydroc. Diesel Fuel (mg/1)				
Hydroc. Stove Oil (mg/1)				
Hydroc. Furnace Oil (mg/1)				
Hydroc Bunker Oil (mg/1)				
Hydroc. Gasoline-Reg. (mg/1)				
Urea (mg/1)			0.02	0.02
Fluoride Dissolved	0.05			0.06

Charlottetown Airport Test Well #7, Depth - 17.44 m
NAQUADAT STN. NO. 10PE01CC0037

Field Parameters	Sept 16/76	Dec 1/76	Feb 9/77
Temp. Water (Deg. °C)			
Spec. Conductance (USIE/cm)			
pH (pH Units)			
Hach D.O. (mg/1)			
Turbidity (JTU)	63.	44.	14.0
Depth of Water Table (m)	12.22*	9.53	11.59
Well pumped	No	Yes	
Lab Parameters			
Temp Water (Lab) Deg. °C	25.	25.	25.
pH (pH units)	8.1	7.9	7.9
Spec. Conduct. (USIE/cm)	390.	240.	300.
Turbidity (JTU)	63.	44.	14.
Colour Apparent (Hel. units)	5.	5.	25.
Calcium Dissolved (mg/1)	38.0	21.7	29.0
Magnesium Dissolved (mg/1)	20.0	15.0	15.5
Potassium Dissolved (mg/1)	9.8	2.3	5.4
Sodium Dissolved (mg/1)	6.6	4.1	6.4
Alkalinity Total (mg/1)	174.	100.	131.7
Chloride Dissolved (mg/1)	10.2	7.1	12.0
Sulphate Dissolved (mg/1)	12.5	10.0	8.7
Phosphorus Total (mg/1)	1.2	0.22	0.23
Silica Reactive (mg/1)			6.2
Manganese Extractable (mg/1)			0.01
Iron Extractable (mg/1)			0.01
Copper Extractable (mg/1)			
Zinc Extractable(mg/1)			
Cadmium Extractable (mg/1)			
Lead Extractable (mg/1)			
Arsenic Total (mg/1)			
Carbon Total Org. (mg/1)	11.2	4.4	4.4
Carbon Total Inorg. (mg/1)			31.0
Nitrogen-NO_3 + NO_2 (mg/1)	1.27	0.98	1.07
Nitrogen-Ammonia Dis.(mg/1)	0.030	L0.005	L0.005
Nitrogen-Total	1.30	1.05	1.07
Phenolic Material (mg/1)	L0.002	L0.002	
Hydroc. Kerosene (mg/1)		L0.5	
Hydroc. Jet Fuel (mg/1)			
Hydroc. Diesel Fuel (mg/1)			
Hydroc. Stove Oil (mg/1)			
Hydroc. Furnace Oil (mg/1)			
Hydroc Bunker Oil (mg/1)			
Hydroc. Gasoline-Reg. (mg/1)		L0.5	
Urea (mg/1)			0.04
Fluoride Dissolved	0.18		

Charlottetown Airport Test Well #8 at Stabilizer's Ltd., Brackley Point Road, Depth 23.7 m
NAQUADAT STN. NO. 10PE01CC0028

Field Parameters	Sept 16/76	Dec 1/76	Apr 6/77	July 26/77	Sept 20/77	Nov 9/77	May 4/78
Temp. Water (Deg. °C)						8.5	8.0
Spec. Conductance (USIE/cm)						780.	620.
pH (pH Units)						7.4	7.3
Hach D.O. (mg/l)							
Turbidity (JTU)	37.	57.		G25	4.5	G25	35.
Depth of Water Table (m)	18.09*	16.73	16.965	17.54	17.33*		12.0
Well pumped	No	No	No	No	No	No	
Lab Parameters							
Temp Water (Lab) Deg. °C	25.	25.		25.	25.	25.	25.
pH (pH units)	8.0	8.0		8.2	7.7	8.6	7.8
Spec. Conduct. (USIE/cm)	500.	630.		639.		723.	743.
Turbidity (JTU)	37.	57.		G25.	4.5	G25.	
Colour Apparent (Rel. units)	5.	L5.		L5.	L5.	5.	5.
Calcium Dissolved (mg/l)	45.0	67.0		61.	70.	67	65.
Magnesium Dissolved (mg/l)	22.4	37.5		32.	50.	38.	31.
Potassium Dissolved (mg/l)	8.2	3.9		5.0	5.4	2.7	2.4
Sodium Dissolved (mg/l)	20.5	15.0		20.	21.	21.	18.
Alkalinity Total (mg/l)	158.	211.		204.		234.	194.
Chloride Dissolved (mg/l)	55.0	47.0		58.	63.	55.	50.0
Sulphate Dissolved (mg/l)	15.9	35.5		26.	21.8	28.0	31.7
Phosphorus Total (mg/l)	0.50	0.22			0.13	0.18	0.23
Silica Reactive (mg/l)					7.2	9.0	8.3
Manganese Extractable (mg/l)							
Iron Extractable (mg/l)							
Copper Extractable (mg/l)							
Zinc Extractable(mg/l)							
Cadmium Extractable (mg/l)							
Lead Extractable (mg/l)							
Arsenic Total (mg/l)							
Carbon Total Org. (mg/l)	10.2	8.3		9.1	5.8	16.5	LO.5
Carbon Total Inorg. (mg/l)				28.2	54.9	64.3	52.0
Nitrogen-NO_3 + NO_2 (mg/l)	3.6	4.4		4.0	3.7	7.5	DE
Nitrogen-Ammonia Dis.(mg/l)	0.020	LO.005		LO.005	LO.005	LO.005	IN
Nitrogen-Total	4.3	9.0		4.0	3.7	3.3	IN
Phenolic Material (mg/l)	LO.002	0.004	LO.002		LO.002	LO.002	LO.002
Hydroc. Kerosene (mg/l)		LO.5					
Hydroc. Jet Fuel (mg/l)							
Hydroc. Diesel Fuel (mg/l)							
Hydroc. Stove Oil (mg/l)							
Hydroc. Furnace Oil (mg/l)							LO.5
Hydroc Bunker Oil (mg/l)							
Hydroc. Gasoline-Reg. (mg/l)		LO.5					LO.5
Urea (mg/l)			.07		.15	LO.01	0.06
Fluoride Dissolved	0.08						

Charlottetown Airport Test Well #8 at Stabilizer's Ltd., Brackley Point Road, Depth 23.7 m
NAQUADAT STN. NO. 10PE01CC0028

Field Parameters	Aug 29/78	Dec 5/78	July 5/79	Aug 22/79	Nov 7/79	Feb 6/80
Temp. Water (Deg. °C)			8.2	9.0	8.0	8.0
Spec. Conductance (USIE/cm)			590.	600.	604.	562.
pH (pH Units)		7.1	7.0	7.0	7.1	7.3
Hach D.O. (mg/1)						
Turbidity (JTU)	2.3	20.	65.	62.	49.	50.
Depth of Water Table (m)	18.21		14.8	16.22	16.085	17.110
Well pumped	No	No	Yes	Yes	Yes	Yes
Lab Parameters						
Temp Water (Lab) Deg. °C	25.	25.	25.	25.	25.	25.
pH (pH units)	7.7	8.1	8.3	7.7	8.1	7.8
Spec. Conduct. (USIE/cm)	660.	620.	588.	620.	600.	584.
Turbidity (JTU)	2.3	20.	65.	62.	60.	60.
Colour Apparent (Rel. units)	IN	IN	5.	5.	5.	10.
Calcium Dissolved (mg/1)	67.	63.	42.	49.	50.	47.
Magnesium Dissolved (mg/1)	36.	42.	24.	25.	22.	23.
Potassium Dissolved (mg/1)	4.0	3.7	4.8	3.4	4.2	3.3
Sodium Dissolved (mg/1)	21.0	24.0	27.0	29.0	29.0	32.0
Alkalinity Total (mg/1)	239.	255.	158.	155.	152.	144.
Chloride Dissolved (mg/1)	63.	62.	82.	92.	50.5	78.
Sulphate Dissolved (mg/1)	25.	22.	15.	14.	15.4	14.6
Phosphorus Total (mg/1)	0.53	0.37	0.15	0.21	0.21	0.17
Silica Reactive (mg/1)	6.7	5.5	5.7	6.3	6.4	7.0
Manganese Extractable (mg/1)			0.03	0.12	0.06	0.07
Iron Extractable (mg/1)			0.95	0.60	0.50	0.27
Copper Extractable (mg/1)			0.027	0.037	0.019	0.005
Zinc Extractable(mg/1)			0.030	0.036	0.018	0.009
Cadmium Extractable (mg/1)						
Lead Extractable (mg/1)			L0.002	0.004	0.002	0.004
Arsenic Total (mg/1)						
Carbon Total Org. (mg/1)	21.5	3.5	11.0	12.0	7.5	8.5
Carbon Total Inorg. (mg/1)	61.5	59.0	38.5	34.5	36.0	32.0
Nitrogen-NO_3 + NO_2 (mg/1)	4.6	3.7	3.3	2.8	2.4	2.6
Nitrogen-Ammonia Dis.(mg/1)	0.005	L0.005	L0.005	L0.005	L0.005	0.010
Nitrogen-Total	5.0	3.9	DE		4.2	3.0
Phenolic Material (mg/1)	IN	0.005	0.004	L0.002		0.003
Hydroc. Kerosene (mg/1)				L0.5	L0.5	L0.5
Hydroc. Jet Fuel (mg/1)				L0.5	L0.5	L0.5
Hydroc. Diesel Fuel (mg/1)				L0.5	L0.5	L0.5
Hydroc. Stove Oil (mg/1)				L0.5	L0.5	L0.5
Hydroc. Furnace Oil (mg/1)				L0.5	L0.5	L0.5
Hydroc Bunker Oil (mg/1)				L0.5	L0.5	L0.5
Hydroc. Gasoline-Reg. (mg/1)				L0.5	DE	DE
Urea (mg/1)	IN	0.06	DE	DE	0.21	L0.01
Fluoride Dissolved						

Charlottetown Airport Test Well #9 near Norwood Avenue, Depth - 21.9 m
NAQUADAT STN. NO. 10PE01CC0027

Field Parameters	Nov 9/79	Feb 5/80
Temp. Water (Deg. °C)		8.0
Spec. Conductance (USIE/cm)		484.
pH (pH Units)		6.8
Hach D.O. (mg/1)		
Turbidity (JTU)	33.	14.
Depth of Water Table (m)	11.269	14.289
Well pumped	Yes	Yes

Lab Parameters		
Temp Water (Lab) Deg. °C	25.	25.
pH (pH units)	6.2	7.5
Spec. Conduct. (USIE/cm)	223.	482.
Turbidity (JTU)	53.	9.6
Colour Apparent (Rel. units)	5.	L5.
Calcium Dissolved (mg/1)	16.	51.
Magnesium Dissolved (mg/1)	9.4	25.
Potassium Dissolved (mg/1)	4.1	1.9
Sodium Dissolved (mg/1)	4.0	5.0
Alkalinity Total (mg/1)	13.8	191.
Chloride Dissolved (mg/1)	4.2	5.6
Sulphate Dissolved (mg/1)	5.0	5.0
Phosphorus Total (mg/1)	0.080	0.010
Silica Reactive (mg/1)	5.1	6.4
Manganese Extractable (mg/1)	0.55	0.11
Iron Extractable (mg/1)	0.35	0.26
Copper Extractable (mg/1)	LO.002	0.003
Zinc Extractable(mg/1)	0.012	0.002
Cadmium Extractable (mg/1)		
Lead Extractable (mg/1)	LO.002-0.003	LO.002-0.003
Arsenic Total (mg/1)		
Carbon Total Org. (mg/1)	4.0	32.5
Carbon Total Inorg. (mg/1)	2.5	47.5
Nitrogen-NO_3 + NO_2 (mg/1)		11.
Nitrogen-Ammonia Dis.(mg/1)	1.1	LO.005
Nitrogen-Total		12.
Phenolic Material (mg/1)		
Hydroc. Kerosene (mg/1)	LO.5	LO.5
Hydroc. Jet Fuel (mg/1)	LO.5	LO.5
Hydroc. Diesel Fuel (mg/1)	LO.5	LO.5
Hydroc. Stove Oil (mg/1)	LO.5	LO.5
Hydroc. Furnace Oil (mg/1)	LO.5	LO.5
Hydroc Bunker Oil (mg/1)	LO.5	LO.5
Hydroc. Gasoline-Reg. (mg/1)	DE.	DE.
Urea (mg/1)	0.14	0.03
Fluoride Dissolved		

Charlottetown Airport Test Well #10 at sewage treatment plant ruins, Norwood Ave. Ext., Depth 11.4m
NAQUADAT STN. NO. 10PE01CC0029

Field Parameters	July 4/79	Aug 21/79	Nov 7/79	Feb 6/80
Temp. Water (Deg. °C)	7.5	7.5	7.5	6.5
Spec. Conductance (USIE/cm)	436.	430.	450.	458.
pH (pH Units)	7.2	6.8	6.9	7.1
Hach D.O. (mg/1)				
Turbidity (JTU)	35.	4.0	12.	6.3
Depth of Water Table (m)	8.75	6.80	6.549	7.895
Well pumped	Yes	Yes	Yes	Yes

Lab Parameters				
Temp Water (Lab) Deg. °C	25.	25.	25.	25.
pH (pH units)	8.0	7.5	8.2	7.5
Spec. Conduct. (USIE/cm)	459.	435.	447.	467.
Turbidity (JTU)	35.	4.0	15.	2.8
Colour Apparent (Rel. units)	5.	L5.	5.	L5.
Calcium Dissolved (mg/1)	41.	47.	46.	49.
Magnesium Dissolved (mg/1)	24.	26.	21.	24.
Potassium Dissolved (mg/1)	1.3	1.5	1.6	1.6
Sodium Dissolved (mg/1)	5.4	5.3	5.5	5.3
Alkalinity Total (mg/1)	185.	167.	171.	181.
Chloride Dissolved (mg/1)	7.0	6.8	7.2	7.6
Sulphate Dissolved (mg/1)	12.	15.	15.0	14.3
Phosphorus Total (mg/1)	0.11	0.080	0.079	0.079
Silica Reactive (mg/1)	6.4	2.5	5.9	7.0
Manganese Extractable (mg/1)	L0.01	0.01	0.01	L0.01
Iron Extractable (mg/1)	1.3	0.20	0.25	0.043
Copper Extractable (mg/1)	0.012	0.004	0.002	L0.002
Zinc Extractable(mg/1)	0.011	0.006	0.004	0.003
Cadmium Extractable (mg/1)				
Lead Extractable (mg/1)	L0.002	0.002	L0.002	L0.002
Arsenic Total (mg/1)				
Carbon Total Org. (mg/1)	12.5	13.0	7.0	12.0
Carbon Total Inorg. (mg/1)	39.0	39.0	43.5	47.0
Nitrogen-NO_3 + NO_2 (mg/1)	7.0	7.0	7.4	8.0
Nitrogen-Ammonia Dis.(mg/1)	L0.005	L0.005	L0.005	L0.005
Nitrogen-Total	DE	8.0	8.1	8.8
Phenolic Material (mg/1)	L0.002	L0.002		L0.002
Hydroc. Kerosene (mg/1)		L0.5		L0.5
Hydroc. Jet Fuel (mg/1)		L0.5		L0.5
Hydroc. Diesel Fuel (mg/1)		L0.5		L0.5
Hydroc. Stove Oil (mg/1)		L0.5		L0.5
Hydroc. Furnace Oil (mg/1)		L0.5		L0.5
Hydroc Bunker Oil (mg/1)		L0.5		L0.5
Hydroc. Gasoline-Reg. (mg/1)		L0.5		DE
Urea (mg/1)	DE	DE	0.04	L0.01
Fluoride Dissolved				

Charlottetown Airport Test Well #11 on crash route at North end of main runway, Dept 1/.3 m
NAQUADAT STN. NO. 10PE01CC0030

Field Parameters	July 4/79	Aug 21/79	Nov 7/79	Feb 5/80
Temp. Water (Deg. °C)	7.5	7.0	8.0	7.0
Spec. Conductance (USIE/cm)	240.	158.	158.	186.
pH (pH Units)	7.3	7.7		6.8
Hach D.O. (mg/l)				
Turbidity (JTU)	7.3	0.4	22.	1.5
Depth of Water Table (m)	8.40	6.80	6.739	7.733
Well pumped	Yes	Yes	Yes	Yes

Lab Parameters				
Temp Water (Lab) Deg. oC	25.	25.	25.	25.
pH (pH units)	8.0	7.5	7.7	7.3
Spec. Conductance (USIE/cm)	214.	173.	184.	198.
Turbidity (JTU)	7.3	0.4	13.	0.9
Colour Apparent (Rel. units)	5.	L5.	L5.	L5.
Calcium Dissolved (mg/l)	21.	16.	17.	19.
Magnesium Dissolved (mg/l)	11.	8.7	9.4	9.7
Potassium Dissolved (mg/l)	0.9	0.9	0.9	1.1
Sodium Dissolved (mg/l)	4.5	4.1	4.4	4.6
Alkalinity Total (mg/l)	83.	65.	68.	72.2
Chloride Dissolved (mg/l)	7.0	5.3	6.3	7.0
Sulphate Dissolved (mg/l)	6.0	7.3	6.8	5.5
Phosphorus Total (mg/l)	0.11	0.12	0.12	0.11
Silica Reactive (mg/l)	3.8	6.3	4.9	6.0
Manganese Extractable (mg/l)	L0.01	0.01	0.01	L0.01
Iron Extractable (mg/l)	0.040	0.15	0.10	0.15
Copper Extractable (mg/l)	L0.002	0.002	L0.002	L0.002
Zinc Extractable(mg/l)	L0.002	0.002	0.003	L0.002
Cadmium Extractable (mg/l)				
Lead Extractable (mg/l)	L0.002	0.002	L0.002	L0.002
Arsenic Total (mg/l)				
Carbon Total Org. (mg/l)	7.5	5.0	4.5	7.5
Carbon Total Inorg. (mg/l)	19.5	14.5	17.0	16.5
Nitrogen-NO_3 + NO_2 (mg/l)	1.4	1.0	1.0	1.7
Nitrogen-Ammonia Dis.(mg/l)	L0.005	L0.005	L0.005	L0.005
Nitrogen-Total	DE	1.1	1.2	1.9
Phenolic Material (mg/l)	L0.002	L0.002	0.002	
Hydroc. Kerosene (mg/l)		L0.5	L0.5	L0.5
Hydroc. Jet Fuel (mg/l)		L0.5	L0.5	L0.5
Hydroc. Diesel Fuel (mg/l)		L0.5	L0.5	L0.5
Hydroc. Stove Oil (mg/l)		L0.5	L0.5	L0.5
Hydroc. Furnace Oil (mg/l)		L-.5	L0.5	L0.5
Hydroc Bunker Oil (mg/l)		L0.5	L0.5	L0.5
Hydroc. Gasoline-Reg. (mg/l)		L0.5	DE	DE
Urea (mg/l)	DE		0.07	0.02
Fluoride Dissolved				

Charlottetown Airport Test Well #A, Depth - 22.73m
NAQUADAT STN. NO. 10PE01CC0039

Field Parameters	Nov 30/76
Temp. Water (Deg. °C)	
Spec. Conductance (USIE/cm)	
pH (pH Units)	
Hach D.O. (mg/1)	46.
Turbidity (JTU)	
Depth of Water Table (m)	10.22
Well pumped	Yes

Lab Parameters	
Temp Water (Lab) Deg. °C	25.
pH (pH units)	7.9
Spec. Conductance (USIE/cm)	140.
Turbidity (JTU)	46.
Colour Apparent (Rel. units)	L5.
Calcium Dissolved (mg/1)	19.5
Magnesium Dissolved (mg/1)	9.0
Potassium Dissolved (mg/1)	1.2
Sodium Dissolved (mg/1)	4.7
Alkalinity Total (mg/1)	76.5
Chloride Dissolved (mg/1)	6.7
Sulphate Dissolved (mg/1)	8.4
Phosphorus Total (mg/1)	0.22
Silica Reactive (mg/1)	
Manganese Extractable (mg/1)	
Iron Extractable (mg/1)	
Copper Extractable (mg/1)	
Zinc Extractable(mg/1)	
Cadmium Extractable (mg/1)	
Lead Extractable (mg/1)	
Arsenic Total (mg/1)	
Carbon Total Org. (mg/1)	2.9
Carbon Total Inorg. (mg/1)	
Nitrogen-NO_3 + NO_2 (mg/1)	1.63
Nitrogen-Ammonia Dis.(mg/1)	L0.005
Nitrogen-Total	1.63
Phenolic Material (mg/1)	L0.002
Hydroc. Kerosene (mg/1)	
Hydroc. Jet Fuel (mg/1)	
Hydroc. Diesel Fuel (mg/1)	
Hydroc. Stove Oil (mg/1)	
Hydroc. Furnace Oil (mg/1)	
Hydroc Bunker Oil (mg/1)	
Hydroc. Gasoline-Reg. (mg/1)	
Urea (mg/1)	
Fluoride Dissolved	

Charlottetown Airport Test Well #8, Depth - 11.07m
NAQUADAT STN. NO. 10PE01CC0040

Field Parameters	Nov 30/76	Feb 9/77	Apr 6/77	July 27/77	Sept 21/77	Nov 9/77	Feb 1/78
Temp. Water (Deg. °C)				7.5		9.2	2.5
Spec. Conductance (USIE/cm)				150.		76.	184.
pH (pH Units)				6.6		9.0	7.9
Hach D.O. (mg/l)							
Turbidity (JTU)							
Depth of Water Table (m)	4.67	5.05	4.47	5.185			
Well pumped	Yes	No	Yes	No		Yes	No
Lab Parameters							
Temp Water (Lab) Deg. °C	25.	25.			25.		25.
pH (pH units)	7.8	8.1	7.8	8.0	7.7	7.9	8.0
Spec. Conductance (USIE/cm)	168.	175.	173.	144.	138.	80.	176.
Turbidity (JTU)	54.	70.	62.	32.	23.	G25.	10.
Colour Apparent (Rel. units)	10.	20.	5.	L5.	L5.	L5.	G100.0
Calcium Dissolved (mg/l)	19.0	19.0	17.5	15.0	14.0	6.0	16.
Magnesium Dissolved (mg/l)	8.4	9.1	9.2	6.7	7.0	3.0	3.7
Potassium Dissolved (mg/l)	0.8	1.4	0.7	0.6	0.6	1.0	0.7
Sodium Dissolved (mg/l)	2.8	3.0	2.9	2.9	2.8	3.7	3.6
Alkalinity Total (mg/l)	68.	72.7	71.7	52.3	53.9	27.5	66.8
Chloride Dissolved (mg/l)	7.0	6.6	8.0	7.5	7.6	5.3	7.8
Sulphate Dissolved (mg/l)	6.4	6.9	6.2	7.0	6.5	4.1	6.7
Phosphorus Total (mg/l)	0.29	0.35	0.26	0.20	0.019	0.019	0.063
Silica Reactive (mg/l)		5.9	3.3		0.50	L0.10	1.1
Manganese Extractable (mg/l)		0.01					
Iron Extractable (mg/l)		0.05					
Copper Extractable (mg/l)							
Zinc Extractable(mg/l)							
Cadmium Extractable (mg/l)							
Lead Extractable (mg/l)							
Arsenic Total (mg/l)							
Carbon Total Org. (mg/l)	4.6	3.8	1.3	2.8	3.0	2.9	L0.5
Carbon Total Inorg. (mg/l)		17.2	17.6	9.3	14.1	6.8	19.7
Nitrogen-NO_3 + NO_2 (mg/l)	0.51	0.63	0.70	0.020	0.050	L0.010	0.59
Nitrogen-Ammonia Dis.(mg/l)	L0.005	0.015	L0.005	0.10	0.40		L0.005
Nitrogen-Total	0.51	0.66	0.70	0.30	0.29	0.17	0.53
Phenolic Material (mg/l)	L0.002		L0.002		L0.002	L0.002	
Hydroc. Kerosene (mg/l)	L0.5						
Hydroc. Jet Fuel (mg/l)							
Hydroc. Diesel Fuel (mg/l)							
Hydroc. Stove Oil (mg/l)							
Hydroc. Furnace Oil (mg/l)							
Hydroc Bunker Oil (mg/l)							
Hydroc. Gasoline-Reg. (mg/l)	L0.5						
Urea (mg/l)		L0.01	0.02		0.02	L0.01	
Fluoride Dissolved			0.06				

Charlottetown Airport Test Well #8
NAQUADAT STN. NO. 10PE01CC0040

Field Parameters	May 3/78	Aug 30/78	Dec 6/78
Temp. Water (Deg. °C)	3.0		7.5
Spec. Conductance (USIE/cm)	140.		200.
pH (pH Units)	8.0		
Hach D.O. (mg/1)			
Turbidity (JTU)			
Depth of Water Table (m)		6.08	
Well pumped	No	No	No

Lab Parameters			
Temp Water (Lab) Deg. oC	25.	25.	25.
pH (pH units)	7.9	8.0	8.0
Spec. Conductance (USIE/cm)	131.	282.	128.
Turbidity (JTU)	28.	20.	25.
Colour Apparent (Rel. units)	L5.	IN	10.
Calcium Dissolved (mg/1)	9.7	18.	12.
Magnesium Dissolved (mg/1)	7.5	8.2	5.5
Potassium Dissolved (mg/1)	0.7	0.6	0.6
Sodium Dissolved (mg/1)	3.1	3.3	2.9
Alkalinity Total (mg/1)	48.0	64.0	42.0
Chloride Dissolved (mg/1)	10.0	10.0	8.8
Sulphate Dissolved (mg/1)	6.1	7.3	6.8
Phosphorus Total (mg/1)	0.032	IN	0.080
Silica Reactive (mg/1)	0.50	2.7	0.80
Manganese Extractable (mg/1)			
Iron Extractable (mg/1)			
Copper Extractable (mg/1)			
Zinc Extractable(mg/1)			
Cadmium Extractable (mg/1)			
Lead Extractable (mg/1)			
Arsenic Total (mg/1)			
Carbon Total Org. (mg/1)	3.8	1.5	3.5
Carbon Total Inorg. (mg/1)	13.5	18.5	11.0
Nitrogen-NO_3 + NO_2 (mg/1)	DE	0.79	LO.05
Nitrogen-Ammonia Dis.(mg/1)	IN	LO.005	0.42
Nitrogen-Total	IN	0.86	0.47
Phenolic Material (mg/1)	LO.002	IN	0.002
Hydroc. Kerosene (mg/1)			
Hydroc. Jet Fuel (mg/1)			
Hydroc. Diesel Fuel (mg/1)			
Hydroc. Stove Oil (mg/1)			
Hydroc. Furnace Oil (mg/1)	LO.5		
Hydroc Bunker Oil (mg/1)			
Hydroc. Gasoline-Reg. (mg/1)	LO.5		
Urea (mg/1)	LO.01	IN	0.09
Fluoride Dissolved			

Charlottetown Airport Test Well #C, Depth 11.98m
NAQUADAT STN. NO. 10PE01CC0041

Field Parameters	Nov 30/76	Apr 6/77
Temp. Water (Deg. °C)		
Spec. Conductance (USIE/cm)		
pH (pH Units)		
Hach D.O. (mg/l)		
Turbidity (JTU)		
Depth of Water Table (m)	3.33	2.19
Well pumped	Yes	Yes
Lab Parameters		
Temp Water (Lab) Deg. °C	25.	25.
pH (pH units)	7.7	8.1
Spec. Conductance (USIE/cm)	215.	192.
Turbidity (JTU)	42.	16.
Colour Apparent (Rel. units)	L5.	10.
Calcium Dissolved (mg/l)	22.5	22.5
Magnesium Dissolved (mg/l)	10.5	11.2
Potassium Dissolved (mg/l)	1.2	0.9
Sodium Dissolved (mg/l)	4.6	4.9
Alkalinity Total (mg/l)	86.0	91.6
Chloride Dissolved (mg/l)	8.4	9.0
Sulphate Dissolved (mg/l)	8.5	9.2
Phosphorus Total (mg/l)	0.09	0.22
Silica Reactive (mg/l)		3.5
Manganese Extractable (mg/l)		
Iron Extractable (mg/l)		
Copper Extractable (mg/l)		
Zinc Extractable(mg/l)		
Cadmium Extractable (mg/l)		
Lead Extractable (mg/l)		
Arsenic Total (mg/l)		
Carbon Total Org. (mg/l)	3.6	L0.5
Carbon Total Inorg. (mg/l)		24.4
Nitrogen-NO_3 + NO_2 (mg/l)	0.25	L0.01
Nitrogen-Ammonia Dis.(mg/l)	0.045	0.010
Nitrogen-Total		0.34
Phenolic Material (mg/l)	L0.002	L0.002
Hydroc. Kerosene (mg/l)	L0.5	
Hydroc. Jet Fuel (mg/l)		
Hydroc. Diesel Fuel (mg/l)		
Hydroc. Stove Oil (mg/l)		
Hydroc. Furnace Oil (mg/l)		
Hydroc Bunker Oil (mg/l)		
Hydroc. Gasoline-Reg. (mg/l)	L0.5	
Urea (mg/l)		0.03
Fluoride Dissolved		0.06

Charlottetown Airport Test Well #D, Depth - 14.45m
NAQUADAT STN. NO. 10PE01CC0042

Field Parameters	Nov 30/76	Feb 9/77	Apr 6/77
Temp. Water (Deg. °C)			
Spec. Conductance (USIE/cm)			
pH (pH Units)			
Hach D.O. (mg/1)			
Turbidity (JTU)			
Depth of Water Table (m)	9.51	10.165	9.815
Well pumped	Yes	Unknown	Yes
Lab Parameters			
Temp Water (Lab) Deg. °C	25.	25.	25.
pH (pH units)	7.9	8.0	7.9
Spec. Conductance (USIE/cm)	195.	153.	788.0
Turbidity (JTU)	6.2	45.	28.
Colour Apparent (Rel. units)	5.	90.	85.
Calcium Dissolved (mg/1)	20.0	15.5	16.0
Magnesium Dissolved (mg/1)	10.5	7.6	9.2
Potassium Dissolved (mg/1)	1.4	1.1	1.2
Sodium Dissolved (mg/1)	4.6	3.3	3.4
Alkalinity Total (mg/1)	86.1	63.8	71.8
Chloride Dissolved (mg/1)	7.6	5.0	5.4
Sulphate Dissolved (mg/1)	7.3	7.6	7.8
Phosphorus Total (mg/1)	0.17	0.34	0.26
Silica Reactive (mg/1)		5.6	3.6
Manganese Extractable (mg/1)		0.01*	
Iron Extractable (mg/1)		0.05	
Copper Extractable (mg/1)			
Zinc Extractable(mg/1)			
Cadmium Extractable (mg/1)			
Lead Extractable (mg/1)			
Arsenic Total (mg/1)			
Carbon Total Org. (mg/1)	L0.5	3.5	1.3
Carbon Total Inorg. (mg/1)		15.9	17.3
Nitrogen-NO_3 + NO_2 (mg/1)	0.54	0.36	0.32
Nitrogen-Ammonia Dis.(mg/1)	L0.005	L0.005	0.005
Nitrogen-Total	0.54	0.37	0.36
Phenolic Material (mg/1)	0.006		L0.002
Hydroc. Kerosene (mg/1)	L0.5		
Hydroc. Jet Fuel (mg/1)			
Hydroc. Diesel Fuel (mg/1)			
Hydroc. Stove Oil (mg/1)			
Hydroc. Furnace Oil (mg/1)			
Hydroc Bunker Oil (mg/1)			
Hydroc. Gasoline-Reg. (mg/1)	L0.5		
Urea (mg/1)		0.36	0.07
Fluoride Dissolved			0.07

Charlottetown Airport Test Well #E, Depth 8.96 m
NAQUADAT STN. NO. 10PE01CC0043

Field Parameters	Nov 30/76	Feb 9/77	Apr 6/77	July 27/77	Sept 21/77	Nov 9/77
Temp. Water (Deg. °C)						8.0
Spec. Conductance (USIE/cm)						142.
pH (pH Units)						8.8
Hach D.O. (mg/1)						
Turbidity (JTU)						
Depth of Water Table (m)	2.86	5.605	3.14	3.695		2.24*
Well pumped	Yes	No	Yes	No	Unknown	Yes
Lab Parameters						
Temp Water (Lab) Deg. °C	25.	25.		25.	25.	25.
pH (pH units)	8.2	8.4	8.3	8.4	8.0	7.3
Spec. Conductance (USIE/cm)	290.	290.	279.	287.	288.	162.
Turbidity (JTU)	55.	34.	5.8	G25.	50.	G25.
Colour Apparent (Rel. units)	10.	55.	L5.	L5.	10.	L5.
Calcium Dissolved (mg/1)	33.0	35.0	34.0	33.0	33.0	11.0
Magnesium Dissolved (mg/1)	15.5	16.0	17.2	13.0	18.0	13.0
Potassium Dissolved (mg/1)	1.0	1.1	0.9	0.8	0.8	1.0
Sodium Dissolved (mg/1)	4.4	4.8	4.7	4.5	4.5	5.1
Alkalinity Total (mg/1)	134.	141.	144.	141.	144.	66.1
Chloride Dissolved (mg/1)	8.1	9.0	9.0	8.2	8.6	8.0
Sulphate Dissolved (mg/1)	8.1	8.3	8.3	8.3	8.3	7.6
Phosphorus Total (mg/1)	0.25	0.19	0.39	0.13	0.041	0.029
Silica Reactive (mg/1)		6.8	4.4		5.7	0.20
Manganese Extractable (mg/1)		0.01				
Iron Extractable (mg/1)		0.04				
Copper Extractable (mg/1)						
Zinc Extractable(mg/1)						
Cadmium Extractable (mg/1)						
Lead Extractable (mg/1)						
Arsenic Total (mg/1)						
Carbon Total Org. (mg/1)	5.3	7.5	1.5	1.0	4.5	2.3
Carbon Total Inorg. (mg/1)		34.5	35.2	30.5	34.3	16.6
Nitrogen-NO_3 + NO_2 (mg/1)	0.18	0.20	0.02	0.030	0.050	LO.010
Nitrogen-Ammonia Dis.(mg/1)	LO.005	LO.005	0.005	0.050	0.030	LO.005
Nitrogen-Total		0.20	0.04	0.12	0.070	0.040
Phenolic Material (mg/1)	LO.002		0.013		LO.002	LO.002
Hydroc. Kerosene (mg/1)	LO.5					
Hydroc. Jet Fuel (mg/1)						
Hydroc. Diesel Fuel (mg/1)						
Hydroc. Stove Oil (mg/1)						
Hydroc. Furnace Oil (mg/1)						
Hydroc Bunker Oil (mg/1)						
Hydroc. Gasoline-Reg. (mg/1)	LO.5					
Urea (mg/1)		LO.01	0.08		0.02	LO.01
Fluoride Dissolved			0.06			

Charlottetown Airport Test Well #E
NAQUADAT STN. NO. 10PE01CC0043

Field Parameters	Feb 1/78	May 3/78	Aug 30/78	Dec 6/78
Temp. Water (Deg.^{o}C)	2.0	6.7		7.5
Spec. Conductance (USIE/cm)	240.			310.
pH (pH Units)	7.8	7.9		6.9
Hach D.O. (mg/1)				
Turbidity (JTU)				
Depth of Water Table (m)			4.52	
Well pumped	No	No	No	No
Lab Parameters				
Temp Water (Lab) Deg. ^{o}C	25.	25.	25.	
pH (pH units)	8.0	8.0	7.8	8.1
Spec. Conductance (USIE/cm)	251.	211.	172.	305.
Turbidity (JTU)	34.	32.	9.	17.
Colour Apparent (Rel. units)	75.	5.	IN	5.
Calcium Dissolved (mg/1)	26.	20.	31.	37.
Magnesium Dissolved (mg/1)	12.0	12.	16.	17.
Potassium Dissolved (mg/1)	0.9	0.8	0.8	0.7
Sodium Dissolved (mg/1)	4.8	4.7	4.6	4.5
Alkalinity Total (mg/1)	113.	92.	126.	146.
Chloride Dissolved (mg/1)	7.2	8.5	11.0	8.8
Sulphate Dissolved (mg/1)	6.8	6.5	7.3	8.7
Phosphorus Total (mg/1)	0.049	0.022	0.42	0.055
Silica Reactive (mg/1)	1.3	2.2	4.8	5.4
Manganese Extractable (mg/1)				
Iron Extractable (mg/1)				
Copper Extractable (mg/1)				
Zinc Extractable(mg/1)				
Cadmium Extractable (mg/1)				
Lead Extractable (mg/1)				
Arsenic Total (mg/1)				
Carbon Total Org. (mg/1)	L0.5	4.8	0.5	1.0
Carbon Total Inorg. (mg/1)	31.7	30.5	39.0	36.5
Nitrogen-NO_3 + NO_2 (mg/1)	0.01	DE	0.26	0.15
Nitrogen-Ammonia Dis.(mg/1)	0.035	IN	0.015	L0.005
Nitrogen-Total	0.08	IN	0.37	0.15
Phenolic Material (mg/1)		L0.002	IN	L0.002
Hydroc. Kerosene (mg/1)				
Hydroc. Jet Fuel (mg/1)				
Hydroc. Diesel Fuel (mg/1)				
Hydroc. Stove Oil (mg/1)				
Hydroc. Furnace Oil (mg/1)		L0.5		
Hydroc Bunker Oil (mg/1)				
Hydroc. Gasoline-Reg. (mg/1)		L0.5		
Urea (mg/1)		0.07	IN	DE
Fluoride Dissolved	0.05			

Charlottetown Water Supply - Union Road Pumping Station (from tap)
NAQUADAT STN. NO. 10PE01CC0044

Field Parameters	Sept 16/76	Nov 30/76	Feb 9/77	Apr 4/77	July 25/77	Sept 20/77	Nov 8/77
Temp. Water (Deg. oC)							
Spec. Conductance (USIE/cm)							290.
pH (pH Units)					6.6		
Hach D.O. (mg/1)							
Turbidity (JTU)							
Depth of Water Table (m)							
Well pumped							
Lab Parameters							
Temp Water (Lab) Deg. oC	25.	25.	25.		25.	25.	
pH (pH units)	8.0	8.2	8.4	7.7	8.2	8.0	8.1
Spec. Conductance (USIE/cm)	290.	290.	285.	269.	284.	280.	283.
Turbidity (JTU)	0.2	0.4	0.5	0.4	0.3	0.7	0.3
Colour Apparent (Rel. units)	5.	L5.	L5.	L5.	L5.	L5.	L5.
Calcium Dissolved (mg/1)	30.	28.5	30.5	30.	29.	28.	30.
Magnesium Dissolved (mg/1)	15.	15.	16.	16.2	16.	17.	17.
Potassium Dissolved (mg/1)	1.3	1.3	1.2	1.3	1.2	1.1	1.1
Sodium Dissolved (mg/1)	6.5	5.7	6.1	6.5	5.9	5.9	6.1
Alkalinity Total (mg/1)	116.0	114.	116.0	117.7	119.	118.	123.
Chloride Dissolved (mg/1)	10.	11.	12.7	11.7	16.	10.	13.
Sulphate Dissolved (mg/1)	8.0	8.1	8.8	8.1	8.3	8.0	7.5
Phosphorus Total (mg/1)	0.11	0.07	0.17	0.08	0.075	0.044	0.070
Silica Reactive (mg/1)			7.1	4.6		7.0	7.5
Manganese Extractable (mg/1)			0.01*				
Iron Extractable (mg/1)			0.05				
Copper Extractable (mg/1)							
Zinc Extractable(mg/1)							
Cadmium Extractable (mg/1)							
Lead Extractable (mg/1)							
Arsenic Total (mg/1)							
Carbon Total Org. (mg/1)	7.6	3.4	4.6	1.2	LO.5	3.2	0.7
Carbon Total Inorg. (mg/1)			28.6	29.4	31.4	27.9	30.6
Nitrogen-NO_3 + NO_2 (mg/1)	1.58	1.72	1.83	1.70	1.6	1.8	1.8
Nitrogen-Ammonia Dis.(mg/1)	0.015	LO.005	LO.005	0.005	LO.005	LO.005	LO.005
Nitrogen-Total	1.50		1.85	1.71	1.7	1.3	1.8
Phenolic Material (mg/1)	LO.002						
Hydroc. Kerosene (mg/1)							
Hydroc. Jet Fuel (mg/1)							
Hydroc. Diesel Fuel (mg/1)							
Hydroc. Stove Oil (mg/1)							
Hydroc. Furnace Oil (mg/1)							
Hydroc Bunker Oil (mg/1)							
Hydroc. Gasoline-Reg. (mg/1)							
Urea (mg/1)							
Fluoride Dissolved				1.7			

Charlottetown Water Supply - Union Road Pumping Station (from tap)
NAQUADAT STN. NO. 10PE01CC0044

Field Parameters	Jan 31/78	May 3/78	Aug 30/78	Dec 5/78
Temp. Water (Deg. °C)		7.5		
Spec. Conductance (USIE/cm)				
pH (pH Units)	7.4	7.4		7.1
Hach D.O. (mg/1)				
Turbidity (JTU)				
Depth of Water Table (m)				
Well pumped				
Lab Parameters				
Temp Water (Lab) Deg. °C	25.	25.	25.	25.
pH (pH units)	7.7	7.8	8.2	8.4
Spec. Conductance (USIE/cm)	295.	287.	282.	285.
Turbidity (JTU)	0.2	0.3	0.1	2.0
Colour Apparent (Rel. units)	L5.	L5.	L5.	5.
Calcium Dissolved (mg/1)	31.	30.	29.	28.0
Magnesium Dissolved (mg/1)	15.	16.	16.	15.5
Potassium Dissolved (mg/1)	1.1	1.2	1.1	1.1
Sodium Dissolved (mg/1)	5.9	6.0	6.2	6.6
Alkalinity Total (mg/1)	118.	111.	115.	113.
Chloride Dissolved (mg/1)	14.	14.5	9.8	11.
Sulphate Dissolved (mg/1)	8.3	7.8	8.3	8.0
Phosphorus Total (mg/1)	0.061	0.075	0.062	0.055
Silica Reactive (mg/1)	7.3	7.1	6.4	5.8
Manganese Extractable (mg/1)				
Iron Extractable (mg/1)				
Copper Extractable (mg/1)				
Zinc Extractable(mg/1)				
Cadmium Extractable (mg/1)				
Lead Extractable (mg/1)				
Arsenic Total (mg/1)				
Carbon Total Org. (mg/1)	L0.5	4.3	L0.5	L0.5
Carbon Total Inorg. (mg/1)	33.2	30.0	30.5	28.0
Nitrogen-NO_3 + NO_2 (mg/1)	1.8	DE	1.7	2.0
Nitrogen-Ammonia Dis.(mg/1)	L0.005	IN	L0.005	L0.005
Nitrogen-Total	1.84	IN	1.7	2.1
Phenolic Material (mg/1)			IN	L0.002
Hydroc. Kerosene (mg/1)				
Hydroc. Jet Fuel (mg/1)				
Hydroc. Diesel Fuel (mg/1)				
Hydroc. Stove Oil (mg/1)				
Hydroc. Furnace Oil (mg/1)				
Hydroc Bunker Oil (mg/1)				
Hydroc. Gasoline-Reg. (mg/1)				
Urea (mg/1)			IN	0.03
Fluoride Dissolved				

Charlottetown Water Supply Brackley Point Road Pumping Station (from tap)
NAQUADAT STN. NO. 10PE01CC0045

Field Parameters	Sept 16/76	Nov 30/76	Feb 9/77	Apr 4/77	July 25/77	Sept 20/77	Nov 9/77
Temp. Water (Deg. °C)							8.0
Spec. Conductance (USIE/cm)							260.
pH (pH Units)					6.3		7.3
Hach D.O. (mg/1)							
Turbidity (JTU)							
Depth of Water Table (m)							
Well pumped							
Lab Parameters							
Temp Water (Lab) Deg. °C	25.	25.	25.		25.	25.	25.
pH (pH units)	7.9	8.0	7.9	7.5	8.2	7.8	7.9
Spec. Conductance (USIE/cm)	285.	265.	260.	231.	262.	265.	250.
Turbidity (JTU)	0.2	0.2	0.7	0.8	0.2	0.5	0.2
Colour Apparent (Rel. units)	L5.	L5.	L5.	5.0	5.	5.	L5.
Calcium Dissolved (mg/1)	27.5	25.0	25.0	24.0	25.0	26.0	25.0
Magnesium Dissolved (mg/1)	17.2	13.0	13.9	14.0	15.0	16.0	15.0
Potassium Dissolved (mg/1)	1.3	2.7	1.1	1.2	1.1	1.0	1.0
Sodium Dissolved (mg/1)	5.7	5.3	5.5	5.2	5.2	5.3	5.3
Alkalinity Total (mg/1)	117.	103.7	101.	94.	106.	108.	103.
Chloride Dissolved (mg/1)	9.8	13.0	12.6	11.3	11.0	9.6	10.7
Sulphate Dissolved (mg/1)	7.7	8.2	8.3	7.9	8.3	8.1	7.7
Phosphorus Total (mg/1)	0.038	0.07	0.13	0.10	0.070	0.065	0.072
Silica Reactive (mg/1)			6.6	4.0		6.3	6.8
Manganese Extractable (mg/1)			0.01				
Iron Extractable (mg/1)			0.05				
Copper Extractable (mg/1)							
Zinc Extractable(mg/1)							
Cadmium Extractable (mg/1)							
Lead Extractable (mg/1)							
Arsenic Total (mg/1)							
Carbon Total Org. (mg/1)	6.7	4.5	3.6	2.2	0.6	3.5	1.6
Carbon Total Inorg. (mg/1)			24.9	24.7	25.7	26.0	27.1
Nitrogen-NO_3 + NO_2 (mg/1)	1.01	2.15	2.30	1.97	2.0	2.3	2.3
Nitrogen-Ammonia Dis.(mg/1)	0.025	L0.005	L0.005	0.010	L0.005	L0.005	
Nitrogen-Total	1.63		3.04	1.98	2.2	1.8	
Phenolic Material (mg/1)	L0.002						
Hydroc. Kerosene (mg/1)							
Hydroc. Jet Fuel (mg/1)							
Hydroc. Diesel Fuel (mg/1)							
Hydroc. Stove Oil (mg/1)							
Hydroc. Furnace Oil (mg/1)							
Hydroc Bunker Oil (mg/1)							
Hydroc. Gasoline-Reg. (mg/1)							
Urea (mg/1)							
Fluoride Dissolved				0.60			

Charlottetown Water Supply Brackley Point Road Pumping Station (from tap)
NAQUADAT STN. NO. 10PE01CC0045

Field Parameters	Jan 31/78	May 3/78	Aug 30/78	Dec 5/78
Temp. Water (Deg. ^oC)		7.0		
Spec. Conductance (USIE/cm)				
pH (pH Units)	7.1	7.4		7.1
Hach D.O. (mg/l)				
Turbidity (JTU)				
Depth of Water Table (m)				
Well pumped				
Lab Parameters				
Temp Water (Lab) Deg. ^oC	25.	25.	25.	25.
pH (pH units)	7.6	7.8	8.1	8.4
Spec. Conductance (USIE/cm)	265.	256.	276.	276.
Turbidity (JTU)	0.2	0.2	2.7	0.5
Colour Apperent (Rel. units)	L5.	L5.	L5.	L5.
Calcium Dissolved (mg/l)	26.	25.	28.	27.
Magnesium Dissolved (mg/l)	15.	14.	16.	17.
Potassium Dissolved (mg/l)	1.0	1.1	1.1	0.9
Sodium Dissolved (mg/l)	5.2	5.4	5.5	5.3
Alkalinity Total (mg/l)	106.	97.	108.	111.
Chloride Dissolved (mg/l)	13.	14.5	11.0	12.0
Sulphate Dissolved (mg/l)	8.2	7.7	7.8	9.3
Phosphorus Total (mg/l)	0.057	0.080	0.048	0.050
Silica Reactive (mg/l)	6.5	6.7	6.8	5.3
Manganese Extractable (mg/l)				
Iron Extractable (mg/l)				
Copper Extractable (mg/l)				
Zinc Extractable(mg/l)				
Cadmium Extractable (mg/l)				
Lead Extractable (mg/l)				
Arsenic Total (mg/l)				
Carbon Total Org. (mg/l)	0.5	4.0	0.5	1.0
Carbon Total Inorg. (mg/l)	26.9	26.0	31.0	28.5
Nitrogen-NO_3 + NO_2 (mg/l)	1.8	DE	2.1	2.2
Nitrogen-Ammonia Dis.(mg/l)	LO.005	IN	LO.005	LO.005
Nitrogen-Total	2.3	IN	2.1	2.2
Phenolic Material (mg/l)			IN	LO.002
Hydroc. Kerosene (mg/l)				
Hydroc. Jet Fuel (mg/l)				
Hydroc. Diesel Fuel (mg/l)				
Hydroc. Stove Oil (mg/l)				
Hydroc. Furnace Oil (mg/l)				
Hydroc Bunker Oil (mg/l)				
Hydroc. Gasoline-Reg. (mg/l)				
Urea (mg/l)			IN	0.02
Fluoride Dissolved				

Charlottetown Water Supply - Malpeque Pumping Station (from tap) West Royalty
NAQUADAT STN. NO. 10PE01CC0025

Field Parameters	Sept 16/76	July 26/77	Nov 9/77	Jan 31/78	May 3/78	Aug 30/78	Dec 5/78
Temp. Water (Deg.^{o}C)			9.5		7.5		
Spec. Conductance (USIE/cm)			380.				
pH (pH Units)			7.3	7.2	7.2		
Hach D.O. (mg/1)							
Turbidity (JTU)							
Depth of Water Table (m)							
Well pumped							
Lab Parameters							
Temp Water (Lab) Deg. ^{o}C	25.		25.	25.	25.	25.	25.
pH (pH units)	7.8	8.2	8.1	7.5	7.9	7.4	8.0
Spec. Conductance (USIE/cm)	290.	335.	358.	359.	365.	401.	415.
Turbidity (JTU)	0.3	1.5	11.	0.3	3.8	1.1	0.7
Colour Apparent (Rel. units)	L5.	L5.	5.	5.	L5.	L5.	L5.
Calcium Dissolved (mg/1)	28.	39.	34.	34.	32.	37.	43.
Magnesium Dissolved (mg/1)	15.5	22.	20.	19.	18.	20.	20.
Potassium Dissolved (mg/1)	1.3	1.3	1.3	1.3	1.4	1.3	1.2
Sodium Dissolved (mg/1)	5.9	9.4	9.8	11.	13.	13.	12.0
Alkalinity Total (mg/1)	122.	144.	122.	124.	112.	147.	153.
Chloride Dissolved (mg/1)	10.0	25.	29.	29.	37.5	21.	24.
Sulphate Dissolved (mg/1)	7.3	14.6	13.5	13.6	12.1	15.0	16.2
Phosphorus Total (mg/1)	0.045	0.075	0.11	0.060	0.070	0.062	0.052
Silica Reactive (mg/1)			7.3	7.8	7.1	6.4	5.5
Manganese Extractable (mg/1)							
Iron Extractable (mg/1)							
Copper Extractable (mg/1)							
Zinc Extractable(mg/1)							
Cadmium Extractable (mg/1)							
Lead Extractable (mg/1)							
Arsenic Total (mg/1)							
Carbon Total Org. (mg/1)	7.9	LO.5	1.4	LO.5	4.6	LO.5	1.5
Carbon Total Inorg. (mg/1)		35.9	30.6	31.4	31.0	39.5	38.5
Nitrogen-NO_3 + NO_2 (mg/1)	1.69	1.9	2.5	2.8	DE	2.8	2.3
Nitrogen-Ammonia Dis.(mg/1)	0.035	LO.005	LO.005	LO.005	IN	LO.005	LO.005
Nitrogen-Total	1.7	2.5	2.9	2.6	IN	2.8	
Phenolic Material (mg/1)	LO.002					In	0.002
Hydroc. Kerosene (mg/1)							
Hydroc. Jet Fuel (mg/1)							
Hydroc. Diesel Fuel (mg/1)							
Hydroc. Stove Oil (mg/1)							
Hydroc. Furnace Oil (mg/1)							
Hydroc Bunker Oil (mg/1)							
Hydroc. Gasoline-Reg. (mg/1)							
Urea (mg/1)						IN	LO.01
Fluoride Dissolved							

Winter River South Branch at Union Road Culvert
NAQUADAT STN. NO. 00PE01CC0042

Field Parameters	Nov 30/76	Apr 4/77	July 26/77	Sept 20/77	Nov 8/77	Jan 31/78	May 3/78
Temp. Water (Deg. ^{o}C)			15.2		5.5	1.8	4.0
Spec. Conductance (USIE/cm)			192.		260.	126.	88.
pH (pH Units)					7.8	7.0	7.1
Hach D.O. (mg/1)							
Turbidity (JTU)							
Depth of Water Table (m)							
Well pumped							
Lab Parameters							
Temp Water (Lab) Deg. ^{o}C	25.		25.	25.	25.	25.	25.
pH (pH units)	6.8	6.7	8.1	8.0	8.0	7.3	7.4
Spec. Conductance (USIE/cm)	95.	82.	180.	210.	270.	129.	136.
Turbidity (JTU)	5.7	2.4	36.	1.7	2.2	2.1	2.3
Colour Apparent (Rel. units)	100.	G100.	85.	G100.	30.	90.	G100.
Calcium Dissolved (mg/1)	5.5	4.2	18.	21.	28.	11.	13.
Magnesium Dissolved (mg/1)	3.0	2.0	9.0	13.	16.	5.2	6.8
Potassium Dissolved (mg/1)	5.5	6.0	3.0	1.3	1.2	1.1	1.4
Sodium Dissolved (mg/1)	4.7	3.3	4.9		5.2	4.1	3.8
Alkalinity Total (mg/1)	14.1	10.	62.	83.5	110.	38.6	44.
Chloride Dissolved (mg/1)	12.0	9.1	11.	0.7	13.	9.3	9.5
Sulphate Dissolved (mg/1)	8.2	5.9	11.0	8.5	8.0	5.5	6.1
Phosphorus Total (mg/1)	0.14	0.21	0.20	0.064	0.051	0.039	0.080
Silica Reactive (mg/1)		1.3		5.1	7.0	3.8	3.3
Manganese Extractable (mg/1)							
Iron Extractable (mg/1)							
Copper Extractable (mg/1)							
Zinc Extractable(mg/1)							
Cadmium Extractable (mg/1)							
Lead Extractable (mg/1)							
Arsenic Total (mg/1)							
Carbon Total Org. (mg/1)	24.8	16.0	12.5	15.7	3.2	2.6	13.1
Carbon Total Inorg. (mg/1)		5.7	14.6	20.5	26.1	17.7	12.5
Nitrogen-NO_3 + NO_2 (mg/1)	0.50	0.16	1.1	0.090	2.1	0.90	DE
Nitrogen-Ammonia Dis.(mg/1)	1.35	0.055	0.15	L0.005	0.020	L0.005	IN
Nitrogen-Total		1.19	1.4	0.91	2.1	.74	IN
Phenolic Material (mg/1)							
Hydroc. Kerosene (mg/1)							
Hydroc. Jet Fuel (mg/1)							
Hydroc. Diesel Fuel (mg/1)							
Hydroc. Stove Oil (mg/1)							
Hydroc. Furnace Oil (mg/1)							
Hydroc Bunker Oil (mg/1)							
Hydroc. Gasoline-Reg. (mg/1)							
Urea (mg/1)							
Fluoride Dissolved		.08					

Winter River South Branch at Union Road Culvert
NAQUADAT STN. NO. 00PE01CC0042

Field Parameters	Aug 29/78	Dec 5/78
Temp. Water (Deg. oC)		1.0
Spec. Conductance (USIE/cm)		230.
pH (pH Units)		7.2
Hach D.O. (mg/l)		
Turbidity (JTU)		
Depth of Water Table (m)		
Well pumped		

Lab Parameters		
Temp Water (Lab) Deg. oC	25.	25.
pH (pH units)	8.2	7.7
Spec. Conductance (USIE/cm)	262.	244.
Turbidity (JTU)	5.3	2.7
Colour Apparent (Rel. units)	40.	10.
Calcium Dissolved (mg/l)	26.	29.
Magnesium Dissolved (mg/l)	15.	19.
Potassium Dissolved (mg/l)	2.7	1.5
Sodium Dissolved (mg/l)	5.1	5.4
Alkalinity Total (mg/l)	113.	95.
Chloride Dissolved (mg/l)	11.	12.
Sulphate Dissolved (mg/l)	7.5	8.6
Phosphorus Total (mg/l)	0.086	0.038
Silica Reactive (mg/l)	1.1	5.0
Manganese Extractable (mg/l)		
Iron Extractable (mg/l)		
Copper Extractable (mg/l)		
Zinc Extractable(mg/l)		
Cadmium Extractable (mg/l)		
Lead Extractable (mg/l)		
Arsenic Total (mg/l)		
Carbon Total Org. (mg/l)	3.5	4.5
Carbon Total Inorg. (mg/l)	32.0	23.5
Nitrogen-NO_3 + NO_2 (mg/l)	0.43	1.1
Nitrogen-Ammonia Dis.(mg/l)	L0.005	0.075
Nitrogen-Total	0.57	1.2
Phenolic Material (mg/l)		
Hydroc. Kerosene (mg/l)		
Hydroc. Jet Fuel (mg/l)		
Hydroc. Diesel Fuel (mg/l)		
Hydroc. Stove Oil (mg/l)		
Hydroc. Furnace Oil (mg/l)		
Hydroc Bunker Oil (mg/l)		
Hydroc. Gasoline-Reg. (mg/l)		
Urea (mg/l)		
Fluoride Dissolved		

Malpeque Stream at Hwy 2 Culvert
NAQUADAT STN. NO. 00PE01CC0043

Field Parameters	July 26/77	Nov 8/77	Jan 31/78	May 3/78	Aug 29/78
Temp. Water (Deg. ^{o}C)		6.0	3.0	8.5	
Spec. Conductance (USIE/cm)		280.	260.	260.	
pH (pH Units)		7.9	7.5	7.7	
Hach D.O. (mg/1)					
Turbidity (JTU)					
Depth of Water Table (m)					
Well pumped					
Lab Parameters					
Temp Water (Lab) Deg. ^{o}C	25.	25.	25.	25.	
pH (pH units)	8.3	8.1	7.8	7.9	8.1
Spec. Conductance (USIE/cm)	225.	281.	292.	269.	138.
Turbidity (JTU)	5.0	1.7	12.	13.	13.
Colour Apparent (Rel. units)	5.	5.	10.	10.	20.
Calcium Dissolved (mg/1)	21.5	28.	27.	23.	10.
Magnesium Dissolved (mg/1)	10.5	16.0	3.8	14.0	3.5
Potassium Dissolved (mg/1)	1.4	1.4	1.4	1.5	1.8
Sodium Dissolved (mg/1)	7.8	8.4	8.2	8.9	8.7
Alkalinity Total (mg/1)	75.	98.9	97.4	87.	30.0
Chloride Dissolved (mg/1)	17.0	20.0	19.0	20.0	15.0
Sulphate Dissolved (mg/1)	11.5	11.8	11.3	11.4	11.0
Phosphorus Total (mg/1)	0.08	0.064	0.10	0.10	0.086
Silica Reactive (mg/1)		5.9	5.7	4.4	0.90
Manganese Extractable (mg/1)					
Iron Extractable (mg/1)					
Copper Extractable (mg/1)					
Zinc Extractable(mg/1)					
Cadmium Extractable (mg/1)					
Lead Extractable (mg/1)					
Arsenic Total (mg/1)					
Carbon Total Org. (mg/1)	4.1	1.3	2.4	6.0	7.5
Carbon Total Inorg. (mg/1)	18.6	25.1	24.3	22.0	6.0
Nitrogen-NO_3 + NO_2 (mg/1)	0.6	1.8	2.2	DE	0.23
Nitrogen-Ammonia Dis.(mg/1)	0.1	L0.005	L0.005	IN	0.015
Nitrogen-Total	0.89	2.0	2.17	IN	0.34
Phenolic Material (mg/1)					
Hydroc. Kerosene (mg/1)					
Hydroc. Jet Fuel (mg/1)					
Hydroc. Diesel Fuel (mg/1)					
Hydroc. Stove Oil (mg/1)					
Hydroc. Furnace Oil (mg/1)					
Hydroc Bunker Oil (mg/1)					
Hydroc. Gasoline-Reg. (mg/1)					
Urea (mg/1)					
Fluoride Dissolved					

APPENDIX III

Parameter Summary

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PARAMETER SUMMARY REPORT

Temp. Water (Deg. C.)

Parameter Code: 0206

Groundwater Summary Samples = 40 (40)*		Surface Water Summary Samples = 42 (42)*	
Percentiles		Percentiles	
90th % =	8.5	90th % =	14.0
75th % =	8.	75th % =	11.0
50th % =	7.5	50th % =	7.0
25th % =	7.	25th % =	5.5
10th % =	6.5	10th % =	3.0
Max =	9.5	Max =	18.5
Min =	2.	Min =	1.0
Mean =	7.3	Mean =	8.1
Std Dev =	1.6	Std Dev =	3.9

VALUES GREATER 90th PERCENTILES

Temp. Water (Deg. C.)

Parameter Code: 0206

Groundwater Summary		Surface Water Summary	
Station #	# of Values	Station #	# of Values
10PE01CC0028	1	00PE01CC0040	2
10PE01CC0040	1	00PE01CC0042	1
10PE01CC0025	1	01PE01CC0002	1

---

*No. of Values Taken in Field

PARAMETER SUMMARY REPORT

Specific Conductance (USIE/CM)

Parameter Code: 0204

Groundwater Summary		Surface Water Summary	
Samples = 154(36)*		Samples = 106(40)*	
Percentiles		Percentiles	
90th %	= 584.	90th %	= 386.
75th %	= 435.	75th %	= 371.
50th %	= 295.	50th %	= 340.
25th %	= 245.	25th %	= 260.
10th %	= 158.	10th %	= 176.
Max	= 788.	Max	= 402.
Min	= 76.	Min	= 75.2
Mean	= 341.	Mean	= 306.1
Std Dev	= 149.	Std Dev	= 85.0

VALUES GREATER 90th PERCENTILES

Specific Conductance (USIE/CM)

Parameter Code: 0204

Groundwater Summary Groundwater Summary		Surface Water Summary Surface Water Summary	
Station #	# of Values	Station #	# of Values
10PE01CC0028	14	00PE01CC0040	8
10PE01CC0042	1		

---

*No. of Values Taken in Field

PARAMETER SUMMARY REPORT

pH (pH Units)

Parameter Code: 1030

Groundwater Summary Samples = 158 (45)*		Surface Water Summary Samples = 104 (41)*	
Percentiles		Percentiles	
90th %	8.3	90th %	8.3
75th %	8.1	75th %	8.1
50th %	7.8	50th %	7.9
25th %	7.3	25th %	7.6
10th %	6.8	10th %	7.3
Max	9.	Max	8.6
Min	6.	Min	6.6
Mean	n/a	Mean	n/a
Std Dev	n/a	Std Dev	n/a

VALUES GREATER 90th PERCENTILES

ph (pH Units)

Parameter Code: 1030

Groundwater Summary

Station #	# of Values
10PE01CC0028	2
10PE01CC0043	3
10PE01CC0044	2
10PE01CC0032	1
10PE01CC0045	1
10PE01CC0031	1
10PE01CC0033	1
10PE01CC0040	1

Surface Water Summary

Station #	# of Values
00PE01CC0040	5
01PE01CC0002	1

---

*No. of Values Taken in Field

PARAMETER SUMMARY REPORT

Dissolved Oxygen (mg/l)

Parameter Code: 0810

Groundwater Summary
Samples = 3(3)*

Percentiles

90th % =
75th % =
50th % = 8.6
25th % =
10th % =

Max = 12.
Min = .2

Mean = 6.9
Std Dev = 5.

Surface Water Summary
Samples = 2(2)*

Percentiles

90th % =
75th % =
50th % = 10.6
25th % =
10th % =

Max = 11.
Min = 10.6

Mean = 10.8
Std Dev = .2

VALUES GREATER 90th PERCENTILES

Dissolved Oxygen (mg/l)

Parameter Code: 0810

Groundwater Summary

Station #	# of Values

Surface Water Summary

Station #	# of Values

---

*No. of Values Taken in Field

PARAMETER SUMMARY REPORT

Turbidity (JTU)

Parameter Code: 0207

Groundwater Summary Samples = 123(9)*		Surface Water Summary Samples = 68(8)*	
Percentiles		**Percentiles**	
90th %	59.	90th %	19.
75th %	35.	75th %	5.
50th %	20.	50th %	1.6
25th %	2.	25th %	.7
10th %	.3	10th %	.3
Max	83.	Max	110.
Min	L.5	Min	.1
Mean	23.3	Mean	7.0
Std Dev	21.6	Std Dev	15.5

VALUES GREATER 90th PERCENTILES

Turbidity (JTU)

Parameter Code: 0207

Groundwater Summary		Surface Water Summary	
Station #	# of Values	Station #	# of Values
10PE01CC0028	4	00PE01CC0040	4
10PE01CC0040	2	01PE01CC0001	1
10PE01CC0037	1	00PE01CC0042	1
10PE01CC0032	2	01PE01CC0002	1
10PE01CC0035	1		

---

*No. of Values Taken in Field

PARAMETER SUMMARY REPORT

Colour Apparent (Rel. Units)

Parameter Code: 0201

Groundwater Summary Samples = 107	Surface Water Summary Samples = 63
Percentiles	Percentiles
90th % = 15.	90th % = 85.
75th % = 5.	75th % = 20.
50th % = L5.	50th % = 5.
25th % = L5.	25th % = L5.
10th % = L5.	10th % = L5.
Max = G100.	Max = 100.
Min = L5.	Min = L5.0
Mean = 9.3	Mean = 18.3
Std Dev = 22.2	Std Dev = 29.3

VALUES GREATER 90th PERCENTILES

Colour Apparent (Rel. Units)

Parameter Code: 0201

Groundwater Summary

Station #	# of Values
10PE01CC0040	2
10PE01CC0037	1
10PE01CC0033	2
10PE01CC0043	2
10PE01CC0035	1
10PE01CC0042	2
10PE01CC0032	1

Surface Water Summary

Station #	# of Values
01PE01CC0002	1
00PE01CC0042	5

PARAMETER SUMMARY REPORT

Calcium Dissolved (mg/l)

Parameter Code: 2010

Groundwater Summary Samples = 127		Surface Water Summary Samples = 68	
Percentiles		Percentiles	
90th % =	51.	90th % =	39.
75th % =	39.	75th % =	37.
50th % =	30.	50th % =	33.
25th % =	25.	25th % =	23.
10th % =	16.	10th % =	11.
Max =	70.	Max =	42.
Min =	6.0	Min =	4.1
Mean =	32.9	Mean =	29.3
Std Dev =	13.9	Std Dev =	10.1

VALUES GREATER 90th PERCENTILES

Calcium Dissolved (mg/l)

Parameter Code: 2010

Groundwater Summary

Station #	# of Values
10PE01CC0033	1
10PE01CC0034	3
10PE01CC0031	1
10PE01CC0028	8

Surface Water Summary

Station #	# of Values
00PE01CC0040	3
01PE01CC0002	1

PARAMETER SUMMARY REPORT

Magnesium Dissolved (mg/l)

Parameter Code: 1210

Groundwater Summary Samples = 123		Surface Water Summary Samples = 68	
Percentiles		Percentiles	
90th %	29.	90th %	20.5
75th %	21.5	75th %	20.
50th %	16.	50th %	18.
25th %	9.2	25th %	11.5
10th %	6.7	10th %	3.8
Max	50.	Max	35.
Min	3.	Min	2.
Mean	16.6	Mean	15.7
Std Dev	8.8	Std Dev	6.7

VALUES GREATER 90th PERCENTILES

Magnesium Dissolved (mg/l)

Parameter Code: 1210

Groundwater Summary

Station #	# of Values
10PE01CC0031	1
10PE01CC0036	2
10PE01CC0033	1
10PE01CC0028	7
10PE01CC0034	1

Surface Water Summary

Station #	# of Values
00PE01CC0040	5
01PE01CC0002	1

PARAMETER SUMMARY REPORT

Potassium Dissolved (mg/l)

Parameter Code: 1910

Groundwater Summary Samples = 116		Surface Water Summary Samples = 63	
Percentiles		Percentiles	
90th % =	7.0	90th % =	3.5
75th % =	2.7	75th % =	1.8
50th % =	1.3	50th % =	1.5
25th % =	1.1	25th % =	1.3
10th % =	.8	10th % =	1.2
Max =	11.	Max =	6.0
Min =	.6	Min =	1.1
Mean =	2.5	Mean =	1.9
Std Dev =	2.5	Std Dev =	1.

VALUES GREATER 90th PERCENTILES

Potassium Dissolved (mg/l)

Parameter Code: 1910

Groundwater Summary		Surface Water Summary	
Station #	# of Values	Station #	# of Values
10PE01CC0010	10	00PE01CC0040	2
10PE01CC0028	1	01PE01CC0002	1
10PE01CC0037	1	01PE01CC0001	1
		00PE01CC0042	2

PARAMETER SUMMARY REPORT

Sodium Dissolved (mg/l)

Parameter Code: 1110

Groundwater Summary	Surface Water Summary
Samples = 124	Samples = 64
Percentiles	Percentiles
90th % = 18.	90th % = 8.7
75th % = 7.6	75th % = 7.4
50th % = 5.3	50th % = 6.2
25th % = 4.5	25th % = 5.7
10th % = 3.6	10th % = 4.2
Max = 32.0	Max = 16.0
Min = 2.8	Min = 1.7
Mean = 7.8	Mean = 6.8
Std Dev = 6.3	Std Dev = 2.4

VALUES GREATER 90th PERCENTILES

Sodium Dissolved (mg/l)

Parameter Code: 1110

Groundwater Summary		Surface Water Summary	
Station #	# of Values	Station #	# of Values
10PE01CC0028	12	00PE01CC0043	1
		01PE01CC0002	5

PARAMETER SUMMARY REPORT

Alkalinity Total (mg/l)

Parameter Code: 1010

	Groundwater Summary Samples = 128 Percentiles	Surface Water Summary Samples = 63 Percentiles
90th %	204.	150.
75th %	155.	143.
50th %	117.7	131.
25th %	87.0	86.2
10th %	64.	44.
Max	255.	168.
Min	9.2	10.
Mean	125.7	112.5
Std Dev	54.	39.2

VALUES GREATER 90th PERCENTILES

Alkalinity Total (mg/l)

Parameter Code: 1010

Groundwater Summary		Surface Water Summary	
Station #	# of Values	Station #	# of Values
10PE01CC0033	3	00PE01CC0040	5
10PE01CC0028	5	01PE01CC0002	1
10PE01CC0031	1		
10PE01CC0036	2		
10PE01CC0034	2		

PARAMETER SUMMARY REPORT

Chloride Dissolved (mg/l)

Parameter Code: 1720

	Groundwater Summary	Surface Water Summary
Samples	131	66
Percentiles		
90th %	62.	20.
75th %	32.	16.
50th %	10.	13.
25th %	7.1	11.
10th %	6.0	9.3
Max	92.	29.
Min	.9	.7
Mean	21.96	14.0
Std Dev	22.63	5.0

VALUES GREATER 90th PERCENTILES

Chloride Dissolved (mg/l)

Parameter Code: 1720

Groundwater Summary		Surface Water Summary	
Station #	# of Values	Station #	# of Values
10PE01CC0028	12	01PE01CC0002	6
		00PE01CC0040	1

PARAMETER SUMMARY REPORT

Fluoride Dissolved (mg/l)

Parameter Code: 0910

Groundwater Summary Samples = 17		Surface Water Summary Samples = 11	
Percentiles		Percentiles	
90th % =	.18	90th % =	.07
75th % =	.13	75th % =	.05
50th % =	.06	50th % =	L.05
25th % =	.06	25th % =	L.05
10th % =	.05	10th % =	L.05
Max =	1.7	Max =	.08
Min =	L.05	Min =	L.05
Mean =	.2	Mean =	.03
Std Dev =	.4	Std Dev =	.03

VALUES GREATER 90th PERCENTILES

Fluoride Dissolved (mg/l)

Parameter Code: 0910

Groundwater Summary

Station #	# of Values
10PE01CC0045	1
10PE01CC0044	1

Surface Water Summary

Station #	# of Values
00PE01CC0042	1

PARAMETER SUMMARY REPORT

Sulfate Dissolved (mg/l)

Parameter Code: 1630

Groundwater Summary	Surface Water Summary
Samples = 122	Samples = 64
Percentiles	Percentiles
90th % = 21.8	90th % = 12.1
75th % = 14.6	75th % = 11.6
50th % = 8.3	50th % = 11.0
25th % = 7.3	25th % = 9.7
10th % = 6.7	10th % = 7.5
Max = 36.2	Max = 14.0
Min = 4.1	Min = 4.8
Mean = 11.8	Mean = 10.4
Std Dev = 6.9	Std Dev = 1.8

VALUES GREATER 90th PERCENTILES

Sulfate Dissolved (mg/l)

Parameter Code: 1630

Groundwater Summary		Surface Water Summary	
Station #	# of Valuer	Station #	# of Values
10PE01CC0028	7	00PE01CC0040	3
10PE01CC0035	5	01PE01CC0002	1

PARAMETER SUMMARY REPORT

Phosphorus Total (mg/l)

Parameter Code: 1541

Groundwater Summary Samples = 111		Surface Water Summary Samples = 60	
Percentiles		Percentiles	
90th % =	.35	90th % =	.19
75th % =	.21	75th % =	.09
50th % =	.11	50th % =	.064
25th % =	.062	25th % =	.051
10th % =	.03	10th % =	.043
Max =	1.2	Max =	.47
Min =	.01	Min =	.020
Mean =	.162	Mean =	.095
Std Dev =	.164	Std Dev =	.085

VALUES GREATER 90th PERCENTILES

Phosphorus Total (mg/l)

Parameter Code: 1541

Groundwater Summary		Surface Water Summary	
Station #	# of Values	Station #	# of Values
10PE01CC0028	3	00PE01CC0042	2
10PE01CC0043	2	01PE01CC0002	2
10PE01CC0036	1	00PE01CC0040	2
10PE01CC0034	1		
10PE01CC0033	1		
10PE01CC0032	2		
10PE01CC0037	1		

PARAMETER SUMMARY REPORT

Silica Reactive (mg/l)

Parameter Code: 1410

Groundwater Summary
Samples = 81

Percentiles

90th % = 7.3
75th % = 6.8
50th % = 5.9
25th % = 4.0
10th % = 2.2

Max = 9.
Min = L.10

Mean = 5.35
Std Dev = 2.05

Surface Water Summary
Samples = 47

Percentiles

90th % = 6.4
75th % = 6.0
50th % = 5.1
25th % = 3.9
10th % = 2.

Max = 7.
Min = .9

Mean = 4.78
Std Dev = 1.60

VALUES GREATER 90th PERCENTILES

Silica Reactive (mg/l)

Parameter Code: 1410

Groundwater Summary

Station #	# of Values
10PE01CC0032	3
10PE01CC0044	1
10PE01CC0033	1
10PE01CC0025	1
10PE01CC0028	2

Surface Water Summary

Station #	# of Values
00PE01CC0040	4
00PE01CC0042	1

PARAMETER SUMMARY REPORT

Manganese Extractable (mg/l)

Parameter Code: 2530

Groundwater Summary Samples = 26		Surface Water Summary Samples = 23	
Percentiles		Percentiles	
90th % =	.07	90th % =	.02
75th % =	.03	75th % =	.02
50th % =	.01	50th % =	.01
25th % =	.01	25th % =	.01
10th % =	L.01	10th % =	L.01
Max =	9.2	Max =	.21
Min =	L.01	Min =	L.01
Mean =	.38	Mean =	.02
Std Dev =	1.76	Std Dev =	.04

VALUES GREATER 90th PERCENTILES

Manganese Extractable (mg/l)

Parameter Code: 2530

Groundwater Summary		Surface Water Summary	
Station #	# of Values	Station #	# of Values
10PE01CC0027	1	00PE01CC0040	2
10PE01CC0028	1		
10PE01CC0035	1		

PARAMETER SUMMARY REPORT

Iron Extractable (mg/l)

Parameter Code: 2630

Groundwater Summary Samples = 26 Percentiles		Surface Water Summary Samples = 25 Percentiles	
90th % =	.95	90th % =	.32
75th % =	.50	75th % =	.069
50th % =	.20	50th % =	.040
25th % =	.05	25th % =	.020
10th % =	.043	10th % =	.008
Max =	2.0	Max =	.70
Min =	.015	Min =	.006
Mean =	.405	Mean =	.101
Std Dev =	.488	Std Dev =	.161

VALUES GREATER 90th PERCENTILES

Iron Extractable (mg/l)

Parameter Code: 2630

Groundwater Summary

Station #	# of Values
10PE01CC0029	1
10PE01CC0031	1
10PE01CC0035	1

Surface Water Summary

Station #	# of Values
00PE01CC0040	2

PARAMETER SUMMARY REPORT

Copper Extractable (mg/l)

Parameter Code: 2930

Groundwater Summary
Samples = 16

Percentiles

90th % = .019
75th % = .012
50th % = .003
25th % = L.002
10th % = L.002

Max = .037
Min = L.002

Mean = 9.00000E-03
Std Dev = .011

Surface Water Summary
Samples = 31

Percentiles

90th % = .002
75th % = .002
50th % = .002
25th % = L.002
10th % = L.002

Max = .009
Min = L.002

Mean = 1.00000E-03
Std Dev = 2.00000E-03

VALUES GREATER 90th PERCENTILES

Copper Extractable (mg/l)

Parameter Code: 2930

Groundwater Summary

Station #	# of Values
10PE01CC0028	2

Surface Water Summary

Station #	# of Values
00PE01CC0040	2

PARAMETER SUMMARY REPORT

Zinc Extractable (mg/l)

Parameter Code: 3030

Groundwater Summary Samples = 16		Surface Water Summary Samples = 31	
Percentiles		Percentiles	
90th % =	.018	90th % =	.003
75th % =	.011	75th % =	L.002
50th % =	.004	50th % =	L.002
25th % =	.002	25th % =	L.002
10th % =	L.005	10th % =	L.002
Max =	.036	Max =	.011
Min =	L.002	Min =	L.002
Mean =	9.00000E-03	Mean =	1.00000E-03
Std Dev =	.01	Std Dev =	2.00000E-03

VALUES GREATER 90th PERCENTILES

Zinc Extractable (mg/l)

Parameter Code: 3030

Groundwater Summary		Surface Water Summary	
Station #	# of Values	Station #	# of Values
10PE01CC0028	2	00PE01CC0040	3

PARAMETER SUMMARY REPORT

Cadmium Extractable (mg/l)

Parameter Code: 4830

Groundwater Summary	Surface Water Summary
Samples = 0	Samples = 9
Percentiles	Percentiles

90th % =
75th % = L.001
50th % = L.001
25th % = L.001
10th % =

Max = L.001
Min = L.001

Mean = 0.000
Std Dev = 0.000

VALUES GREATER 90th PERCENTILES

Cadmium Extractable (mg/l)

Parameter Code: 4830

Groundwater Summary

Station #	# of Values

Surface Water Summary

Station #	# of Values

PARAMETER SUMMARY REPORT

Lead Extractable. (mg/1

Parameter Code: 8230

Groundwater Summary Samples = 16	Surface Water Summary Samples = 29
Percentiles	Percentiles
90th % = .003	90th % = .002
75th % = .002	75th % = L.002
50th % = .002	50th % = L.002
25th % = L.002	25th % = L.002
10th % = L.002	10th % = L.002
Max = .004	Max = .003
Min = L.002	Min = L.002
Mean = 1.00000E-03	Mean = .000
Std Dev = 1.00000E-03	Std Dev = 1.00000E-03

VALUES GREATER 90th PERCENTILES

Lead Extractable. (mg/1)

Parameter Code: 8230

Groundwater Summary

Station #	# of Values

Surface Water Summary

Station #	# of Values
00PE01CC0040	1
01PE01CC0002	1
01PE01CC0001	1

PARAMETER SUMMARY REPORT

Arsenic Total (mg/l)

Parameter Code: 3300

Groundwater Summary Samples = 0		Surface Water Summary Samples = 8	
Percentiles		Percentiles	
90th % =		90th % =	
75th % =		75th % =	L.005
50th % =		50th % =	L.005
25th % =		25th % =	L.005
10th % =		10th % =	
Max =		Max =	L.005
Min =		Min =	L.005
Mean =		Mean =	0.000
Std Dev =		Std Dev =	0.000

VALUES GREATER 90th PERCENTILES

Arsenic Total (mg/l)

Parameter Code: 3300

Groundwater Summary		Surface Water Summary	
Station #	# of Values	Station #	# of Values

PARAMETER SUMMARY REPORT

Carbon Total Organic (mg/l)

Parameter Code: 0600

Groundwater Summary
Samples = 114

Percentiles

90th % = 12.5
75th % = 8.3
50th % = 4.4
25th % = 1.5
10th % = L0.5

Max = 54.4
Min = L0.5

Mean = 6.6
Std Dev = 8.8

Surface Water Summary
Samples = 63

Percentiles

90th % = 15.7
75th % = 11.0
50th % = 6.0
25th % = 2.6
10th % = L0.5

Max = 24.8
Min = L0.5

Mean = 7.3
Std Dev = 5.7

VALUES GREATER 90th PERCENTILES

Carbon Total Organic (mg/l)

Parameter Code: 0600

Groundwater Summary

Station #	# of Values
10PE01CC0029	1
10PE01CC0035	4
10PE01CC0028	2
10PE01CC0027	1
10PE01CC0034	1
10PE01CC0036	1

Surface Water Summary

Station #	# of Values
00Pe01CC0042	2
00PE01CC0040	4

PARAMETER SUMMARY REPORT

Carbon Total Inorganic (mg/1)

Parameter Code: 0605

Percentiles	Groundwater Summary Samples = 89	Surface Water Summary Samples = 56
90th %	48.6	35.5
75th %	38.5	32.5
50th %	30.6	28.0
25th %	24.4	22.7
10th %	15.9	15.5
Max	64.3	44.0
Min	6.8	5.7
Mean	31.6	27.5
Std Dev	12.5	8.4

VALUES GREATER 90th PERCENTILES

Carbon Total Inorganic (mg/1)

Parameter Code: 0605

Groundwater Summary

Station #	# of Values
10PE01CC0035	1
10PE01CC0028	5
10PE01CC0033	2
10PE01CC0034	1

Surface Water Summary

Station #	# of Values
00PE01CC0040	4
01PE01CC0002	2

PARAMETER SUMMARY REPORT

Nitrogen Dissolved NO_3 & NO_2 (mg/l)

Parameter Code: 0711

Groundwater Summary Samples = 114 Percentiles	Surface Water Summary Samples = 60 Percentiles
90th % = 4.4	90th % = 5.7
75th % = 2.7	75th % = 4.9
50th % = 1.8	50th % = 3.6
25th % = .7	25th % = 1.7
10th % = .02	10th % = .60
Max = 11.	Max = 6.4
Min = L.005	Min = .15
Mean = 2.164	Mean = 3.38
Std Dev = 2.234	Std Dev = 1.84

VALUES GREATER 90th PERCENTILES

Nitrogen Dissolved NO_3 & NO_2 (mg/l)

Parameter Code: 0711

Groundwater Summary		Surface Water Summary	
Station #	# of Values	Station #	# of Values
10PE01CC0028	3	00PE01CC0040	6
10PE01CC0033	1		
10PE01CC0036	1		
10PE01CC0029	4		
10PE01CC0027	1		

PARAMETER SUMMARY REPORT

Nitrogen Dissolved Ammonia (mg/l)

Parameter Code: 0755

Groundwater Summary Samples = 108	Surface Water Summary Samples = 58
Percentiles	Percentiles
90th % = 0.1	90th % = 0.14
75th % = 0.015	75th % = 0.055
50th % = L0.005	50th % = L0.005
25th % = L0.005	25th % = L0.005
10th % = L0.005	10th % = L0.005
Max = 7.32	Max = 1.35
Min = L0.005	Min = L0.005
Mean = .277	Mean = .069
Std Dev = 1.133	Std Dev = .202

VALUES GREATER 90th PERCENTILES

Nitrogen Dissolved Ammonia (mg/l)

Parameter Code: 0755

Groundwater Summary		Surface Water Summary	
Station #	# of Values	Station #	# of Values
10PE01CC0035	8	00PE01CC0040	2
10PE01CC0040	2	01PE01CC0002	1
10PE01CC0034	1	00PE01CC0042	1

PARAMETER SUMMARY REPORT

Nitrogen Total (mg/l)

Parameter Code: 0760

Groundwater Summary	Surface Water Summary
Samples = 105	Samples = 47
Percentiles	Percentiles
90th % = 4.8	90th % = 6.2
75th % = 3.3	75th % = 5.4
50th % = 1.85	50th % = 3.6
25th % = .99	25th % = 1.9
10th % = .29	10th % = .91
Max = 12.	Max = 8.3
Min = .03	Min = .34
Mean = 2.44	Mean = 3.55
Std Dev = 2.2	Std Dev = 2.07

VALUES GREATER 90th PERCENTILES

Nitrogen Total (mg/l)

Parameter Code: 0760

Groundwater Summary		Surface Water Summary	
Station #	# of Values	Station #	# of Values
10PE01CC0028	3	00PE01CC0040	5
10PE01CC0036	1		
10PE01CC0033	1		
10PE01CC0029	4		
10PE01CC0027	1		

PARAMETER SUMMARY REPORT

Urea (mg/l)

Parameter Code: 0772

Groundwater Summary Samples = 50		Surface Water Summary Samples = 19	
Percentiles		Percentiles	
90th % =	.09	90th % =	.22
75th % =	.07	75th % =	.06
50th % =	.03	50th % =	.03
25th % =	L.01	25th % =	L.01
10th % =	L.01	10th % =	L.01
Max =	.36	Max =	1.6
Min =	L.01	Min =	L.01
Mean =	.05	Mean =	.16
Std Dev =	.06	Std Dev =	.39

VALUES GREATER 90th PERCENTILES

Urea (mg/l)

Parameter Code: 0772

Groundwater Summary

Station #	# of Values
10PE01CC0040	1
10PE01CC0027	1
10PE01CC0028	2
10PE01CC0042	1

Surface Water Summary

Station #	# of Values
00PE01CC0040	2

PARAMETER SUMMARY REPORT

Phenolic Material (mg/l)

Parameter Code: 0653

Groundwater Summary Samples = 63	Surface Water Summary Samples = 0
Percentiles	Percentiles

90th % = 0.006
75th % = .002
50th % = L.002
25th % = L.002
10th % = L.002

Max = .017
Min = L.002

Mean = 2.00000E-03
Std Dev = 3.00000E-03

VALUES GREATER 90th PERCENTILES

Phenolic Material (mg/l)

Parameter Code: 0653

Groundwater Summary		Surface Water Summary	
Station #	# of Values	Station #	# of Values
10PE01CC0035	3		
10PE01CC0033	1		
10PE01CC0043	1		

PARAMETER SUMMARY REPORT

Hydroc. Gasoline-Premium (mg/l)

Parameter Code: 0657

Groundwater Summary Samples = 105		Surface Water Summary Samples = 56	
Percentiles		Percentiles	
90th % =	L.5	90th % =	L.5
75th % =	L.5	75th % =	L.5
50th % =	L.5	50th % =	L.5
25th % =	L.5	25th % =	L.5
10th % =	L.5	10th % =	L.5
Max =	L.5	Max =	L.5
Min =	L.5	Min =	L.5
Mean =	0.	Mean =	0.0
Std Dev =	0.	Std Dev =	0.0

VALUES GREATER 90th PERCENTILES

Hydroc. Gasoline-Premium (mg/l)

Parameter Code: 0657

Groundwater Summary		Surface Water Summary	
Station #	# of Values	Station #	# of Values

PARAMETER SUMMARY REPORT

Phosphorus, Diss Inorganic (mg/l)

Parameter Code: 1536

Groundwater Summary Samples = 0		Surface Water Summary Samples = 3	
Percentiles		Percentiles	
90th % =		90th % =	
75th % =		75th % =	
50th % =		50th % =	.035
25th % =		25th % =	
10th % =		10th % =	
Max =		Max =	.044
Min =		Min =	.005
Mean =		Mean =	.028
Std Dev =		Std Dev =	.017

VALUES GREATER 90th PERCENTILES

Phosphorus, Diss Inorganic (mg/l)

Parameter Code: 1536

Groundwater Summary		Surface Water Summary	
Station #	# of Values	Station #	# of Values

PARAMETER SUMMARY REPORT

Phosphorus, Total Diss. (mg/1)

Parameter Code: 1510

Groundwater Summary	Surface Water Summary
Samples = 0	Samples = 1
Percentiles	Percentiles
	90th % =
	75th % =
	50th % = .22
	25th % =
	10th % =
	Max = .22
	Min = .22
	Mean = .22
	Std Dev = 0.00

VALUES GREATER 90th PERCENTILES

Phosphorus, Total Diss. (mg/1)

Parameter Code: 1510

Groundwater Summary		Surface Water Summary	
Station #	# of Values	Station #	# of Values

PARAMETER SUMMARY REPORT

Mercury Extractable (ug/l)

Parameter Code: 8031

Groundwater Summary	Surface Water Summary
Samples = 0	Samples = 3
Percentiles	Percentiles

90th % =
75th % =
50th % = L.05
25th % =
10th % =

Max = L.05
Min = L.05

Mean = 0.00
Std Dev = 0.00

VALUES GREATER 90th PERCENTILES

Mercury Extractable (ug/l)

Parameter Code: 8031

Groundwater Summary		Surface Water Summary	
Station #	# of Values	Station #	# of Values

PARAMETER SUMMARY REPORT

Residue Nonfiltr. (mg/l)

Parameter Code: 1040

Groundwater Summary	Surface Water Summary
Samples = 6	Samples = 5
Percentiles	Percentiles
90th % =	90th % =
75th % = 199.	75th % = 27.2
50th % = 74.	50th % = 22.4
25th % = 40.	25th % = 2.0
10th % =	10th % =
Max = 200.	Max = 32.4
Min = L10.	Min = 2.0
Mean = 112.2	Mean = 20.4
Std Dev = 78.3	Std Dev = 10.4

VALUES GREATER 90th PERCENTILES

Residue Nonfiltr. (mg/l)

Parameter Code: 1040

Groundwater Summary		Surface Water Summary	
Station #	# of Values	Station #	# of Values

PARAMETER SUMMARY REPORT

Residue Filterable (mg/l)

Parameter Code: 1045

Groundwater Summary	Surface Water Summary
Samples = 6	Samples = 0
Percentiles	Percentiles

90th % =
75th % = 244.
50th % = 73.5
25th % = 47.9
10th % =

Max = 394.
Min = 47.9

Mean = 164.6
Std Dev = 125.6

VALUES GREATER 90th PERCENTILES

Residue Filteragle (mg/l)

Parameter Code: 1045

Groundwater Summary		Surface Water Summary	
Station #	# of Values	Station #	# of Values

PARAMETER SUMMARY REPORT

Residue Fixed Filt (550° C) (mg/l)

Parameter Code: 1055

Groundwater Summary
Samples = 1

Percentiles

90th % =
75th % =
50th % = 331.
25th % =
10th % =

Max = 331.
Min = 331.

Mean = 331.
Std Dev = 0.

Surface Water Summary
Samples = 0

Percentiles

VALUES GREATER 90th PERCENTILES

Residue Fixed Filt (550° C) (mg/l)

Parameter Code: 1055

Groundwater Summary		Surface Water Summary	
Station #	# of Values	Station #	# of Values

PARAMETER SUMMARY REPORT

Residue Fixed Nonfiltr. (mg/l)

Parameter Code: 1050

Groundwater Summary Samples = 4	Surface Water Summary Samples = 0
Percentiles	Percentiles

90th % =
75th % = 201.
50th % = 160.
25th % = L10.0
10th % =

Max = 204.
Min = L10.0

Mean = 141.3
Std Dev = 83.4

VALUES GREATER 90th PERCENTILES

Residue Fixed Nonfiltr. (mg/l)

Parameter Code: 1050

Groundwater Summary		Surface Water Summary	
Station #	# of Values	Station #	# of Values